THIS MANUEL HAS CALIB. PROCEDURE CORRECTIONS.

INSTRUCTION MANUAL

MODEL 304TDL

TRACKING
WAVE AND SPECTRUM ANALYZER

FOR SERIAL NO. 1142

Quan-Tech®
Div. of KMS Industries, Inc.

DO NOT LOAN

Specialists in Electronic Instrumentation

43 South Jefferson Road Whippany, New Jersey 07981
Telephone: (201) 887-5508

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CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Quan-Tech Laboratories, Inc. warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electronic tubes and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misadjustments, misuse, or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

Calibration checks of this instrument can easily be made in accordance with the instruction manual. Routine readjustments should never be attempted. If, however, the instrument has been damaged and requires recalibration or alignment, explicit calibration procedures as defined in the instruction manual must be followed.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

SHIPPING

The instruments should be packed in their original containers, or in a strong exterior container and surrounded by two inches of shock absorbing material.

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43 SOUTH JEFFERSON ROAD WHIPPANY, NEW JERSEY 07981

201-887-5508

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A. DESCRIPTION

The Model 304TDL is a multi-purpose instrument. It is not only useful as a precision wave analyzer for harmonic measurements and Fourier analysis of complex signals, but its three selectable flat-top bandwidths make it ideally suited for spectral density analysis of random signals.

The Model 304TDL features electronic tuning, using a stable voltage controlled oscillator and offers a five digit display (i.e. resolution to 0.1 Hz). A six position MODE switch controls the tuning functions. In the MODE OFF position the instrument acts as a normal, manually tuned wave analyzer. In the AFC position the Analyzer will track a drifting signal and follow it over a limited frequency range determined by the bandwidth. In the TRACK position, the instrument will lock onto a signal and follow it over the whole or discrete portions of the tuning range. In the SWEEP position, the Analyzer will start at the frequency to which the unit is tuned, and scan upward in frequency over the whole or discrete portions of the tuning range, as determined by a sweep increment switch. In the SEARCH & TRACK position, the instrument will scan as in the SWEEP position, until it finds a signal, whereupon it will lock onto the signal and track it as in the TRACK mode. If the signal disappears, the analyzer will continue to scan automatically until the original signal or a new one is found. Since the sweep time, sweep increment, averaging time, and bandwidth are interdependent, a red light will appear if the various switches are set to a combination which would lead to erroneous results. With the MODE switch in the EXT position, the instrument may be tuned by an external DC voltage.

Two or more Model 304TDLs may be connected together without modification to form a multi-channel, master-slave analyzer system suitable for mechanical impedance and transfer function analysis.*

* In multi-channel installations, where the slaved units never need to work independently, we recommend the Model 1304L, which has a built-in phase meter but no tuning or sweep features. Mechanical impedance and transfer function analysis is simplified at a considerable saving in cost.

A multiplicity of outputs greatly increases the versatility of the Model 304TDL. When used with an X-Y plotter it can automatically make an amplitude vs. frequency or amplitude-phase plot of the characteristics of an electronic or electromechanical system. When used with an oscilloscope, X-Y plotter, or strip-chart recorder, it becomes a spectrum analyzer whose center frequency, sweep width and resolution can all be varied over wide limits. Averaging time, bandwidth, and sweep speed can be selected for optimum results in random signal analysis.

B. SPECIFICATIONS

FREQUENCY RANGE:	1.0 to 5000 Hz
READOUT ACCURACY:	±0.01% or 0.1 Hz
SELECTIVITY:	Three pass bands, 1 Hz, 10 Hz, and 100 Hz at 3 db down, with a broadband to 6500 Hz, selectable by a front panel switch. The filter design is maximally flat (Butterworth approximation) with 24 db roll-off.
VOLTAGE RANGE:	30 uV to 300 volts full scale in 10 db steps; also a variable gain control of 20 db.
VOLTAGE ACCURACY:	±5% of full scale reading.
LOG RANGE:	0 db to -70 db
LOG ACCURACY:	±2 db
DYNAMIC RANGE:	Greater than 70 db for Fourier analysis; greater than 40 db for random signal analysis.
INPUT IMPEDANCE:	1 Megohm.
METER AVERAGING TIMES:	Less than 0.1, approximately 1, 10 and 100 seconds, switch selectable.
TUNING MODES:	Manual, AFC, Track, Sweep, Search and Track and External.
AFC RANGE:	Approximately 4 bandwidths.
TRACK INCREMENT:	50,100,500,1000, or 5000 Hz from tuned frequency, switch selectable.

TRACKING THRESHOLD: Adjustable from approximately 5% to 50% of full scale.

SWEEP TIME: 5,50,500, or 5000 seconds, switch selectable.

SWEEP RANGE: 50,100,500,1000 or 5000 Hz, switch selectable.

SWEEP MODES: Single or Automatic, with reset.

EXTERNAL MODE: ±5 volts for ± sweep range from tuned frequency.

ANALOG OUTPUTS:

SWEEP ANALOG: 0 to +5 volts for any sweep increment; available at front panel and rear connector.

METER ANALOG: 0 to +1 volt proportional to meter deflection; available at front panel and rear connector.

BFO: Sine wave output at the frequency to which the instrument is tuned. Variable to approximately 1 volt RMS into 600 ohms.

RESTORED FREQUENCY: A replica of the input signal,filtered in accordance with tuning and bandwidth.

Note: Either BFO or RESTORED output is selected by a switch available at front panel and rear connector.(Simultaneous BFO and RESTORED available as an option.)

The following are available at rear connector only.

FREQUENCY ANALOG: A positive DC voltage where 1 millivolt equals 1 Hz.

PHASE ANALOG: In-phase and quadrature components, each equal to approximately 1 volt peak-to-peak for full scale deflection

MASTER-SLAVE CONNECTIONS:	10 KHz crystal controlled and 10 to 15 KHz variable.
POWER INPUT:	117/234 VAC, 50 to 400 Hz, 15 Watts.
DIMENSIONS:	16" wide x 11 1/2" high x 12" deep.
WEIGHT:	30 lbs.

A thorough understanding of an instrument and its principles of operation greatly enhance its usefulness. The Model 304TDL Wave and Spectrum Analyzer is a precision instrument capable of performing accurate signal analysis. For the most effective application of this equipment we strongly recommend that the prospective operator read Section 3, the Theory of Operation, before using the instrument.

A study of both the block diagram and the following description, along with the panel markings, will help to familiarize the operator with the functions of the various panel controls.

A. DESCRIPTION OF CONTROLS, INPUTS AND OUTPUTS

1. MANUAL TUNING - The COARSE and FINE controls can each change the frequency of the voltage controlled oscillator (VCO), thereby tuning the instrument. The controls differ in both range and resolution, but are alike in that each control precisely converts angular motion to a change in frequency of the VCO.

2. AUTOMATIC TUNING MODES - In addition to manual control of the VCO, provision has been made to electronically tune it in any of several modes as selected by the MODE switch.

   a. In the AFC mode, the instrument will follow a signal which moves no more than approximately four instrument bandwidths.

   b. In the TRACK mode, the instrument will track a moving signal over selectable increments of the instrument tuning range. Increment width is selected by means of the RANGE control. A rear access control (TRACKING THRESHOLD ADJUST) is provided to permit amplitude discrimination of the tracked signal.

   c. In the SWEEP mode, the operator may scan in its entirety or incrementally, the spectrum from 1 Hz to 5KHz. The increment width again is selectable by means of the RANGE control. The scan time per range increment is selectable by means of the TIME control (5 to 5000 seconds).

   d. The SEARCH AND TRACK mode is a combination of the SWEEP and the TRACK mode. One may electronically scan the spectrum or portions thereof, as in the SWEEP mode. When a signal of given amplitude, as determined by the TRACKING THRESHOLD ADJUST is found, the instrument will automatically switch to the TRACK mode and track the signal. If the signal moves beyond the range increment or drops below the

pre-set threshold, the instrument will revert to the scanning mode until it once again finds a signal.

e. Provision has been made for the operator to externally program the electronically tuned VCO by means of a connector at the rear of the instrument. This function is accomplished with the MODE switch in the EXT position.

f. The RESET/SINGLE/AUTO switch provides for single or repetitive scanning in the SWEEP or SEARCH and TRACK modes of operation.

The RESET is an inhibit position for the AFC, TRACK, SWEEP, or SEARCH AND TRACK modes. An analog voltage is available at the SWEEP ANALOG jack for operating oscilloscopes, recorders, etc.

3. MASTER/SLAVE operation

This mode of operation is controlled by two switches at the rear of the Model 304TDL. For normal or master operation, the MASTER/SLAVE switches are left in the MASTER position. The switches are thrown to the SLAVE position of one wishes to drive one or more 304TDLs as slave units, subordinate to a 304TDL designated as MASTER. For instance, if one wishes to make simultaneous electronic measurements of two or more points related in phase and amplitude by some complex transfer function, one may use two or more 304TDL Wave Analyzers as slaved units, driven by the master unit.

4. SENSITIVITY

The METER MULTIPLIER, VARIABLE GAIN and MILLIVOLTS FULL SCALE controls set the instrument's sensitivity and provide for a combined range of 130 db. The METER MULTIPLIER and VARIABLE GAIN controls are associated with the input circuits and serve to adjust the input signal level to the correct value for analysis. The MILLIVOLTS FULL SCALE switch is, in essence, a range switch for the voltmeter. The sensitivity of the Analyzer is increased in 10 db increments as this control is rotated counterclockwise. For absolute amplitude measurements, the 20 db VARIABLE GAIN control should be rotated clockwise to the CALIBRATED position, the meter will then read directly in millivolts times the METER MULTIPLIER.

In the LOG position of the MILLIVOLT FULL SCALE switch, the instrument sensitivity is 1000 mv times the METER MULTIPLIER setting. The dynamic range in this mode of operation is 70 db, which can be read on the lower DB scale provided.

5. SELECTIVITY:

The overall passband of the system is controlled by the BANDWIDTH switch and may be set to 1,10,100, or 6500 Hz. In the 6500 Hz position the instrument functions as a broadband AC averaging voltmeter. This position is used to determine whether or not a signal exists in the input which might tend to overload the instrument. The instrument full scale reading in this case is equal to the METER MULTIPLIER setting times 1000 mv.

6. METERING

The METER T.C. switch provides for the selection of meter averaging times. The operator will find it helpful in that the averaging time can be changed by the same ratio as the system bandwidth,namely , 10:1. The selectable averaging time is of particular usefulness in the measurement of noisy signals.

The METER ZERO controls provide a means of periodically balancing critically matched circuits which are subject to change with time and temperature. Circuit unbalance is indicated by a finite meter reading with no signal applied and should be "zeroed out" for correct operation. (See page 2 - 4, #3)

For recording purposes, the METER ANALOG voltage is made available at both a jack on the front panel and at a connector at the rear of the instrument.

7. BFO AND RESTORED

The BFO is a sine wave equal to the frequency to which the instrument is tuned, whereas the RESTORED signal is equal to the input signal after it has been passed through a 1,10, or 100 filter and therefore is only available when the instrument is tuned to an input signal. Either of these signals may be selected, and its amplitude adjusted, by the two controls provided.

B. INITIAL OPERATION

1. Connect the instrument to a suitable source of power. Refer to the plate located near the power cord for the voltage and frequency for which the instrument is wired. (See Section 4)

2. Allow at least 10 minutes for the instrument to stabilize before making any adjustments.

3. Zero the meter as follows:

   a. Set the frequency such that the instrument is tuned neither to an incoming signal nor the zero frequency carrier.

   b. Turn the MILLIVOLTS switch counterclockwise to progressively more sensitive ranges. As the sensitivity of the instrument is increased, a residual voltage may be discernible. Alternately adjust the METER ZERO controls for a minimum meter reading, adjusting for the best possible null on the most sensitive range. (This should be less than 2% of full scale).

   Note: The instrument is now ready for operation. However, for best performance, the above procedure should be repeated periodically.

C. MANUAL OPERATION

The actual procedure for instrument operation depends on the nature of the test to be performed. A typical example of manual operation is as follows:

A one volt, 1 KHz signal is to be analyzer for harmonic distortion.

1. Set BANDWIDTH switch to 6500 Hz.

2. Set MILLIVOLT FULL SCALE switch to 1000.

3. Set METER MULTIPLIER switch to X1.

4. Turn the VARIABLE GAIN control clockwise to CALIBRATED position.

5. Select METER T.C. of .1 sec.

6. Connect the signal to the INPUT.

The meter should read approximately full scale. If it does not, the VARIABLE GAIN control may be adjusted such that it does. If the meter reads over full scale, it indicates that there is a signal present at the INPUT, lying within the 6500 Hz range, which will overload the instrument front end. If the range of the VARIABLE GAIN control is not sufficient to bring the meter reading to full scale, the METER MULTIPLIER should be switched to the X 10 or X 100 position in order to do so.

7. Set the BANDWIDTH to 100 Hz.

8. Tune the FREQUENCY COARSE control to the 1 KHz signal.

9. Adjust MILLIVOLTS FULL SCALE switch to obtain a full scale meter reading.

If there had been only the 1 Volt, 1 KHz signal present at the INPUT the meter would have read full scale in the 6500 Hz BANDWIDTH switch position with a METER MULTIPLIER setting of X 1 and a MILLIVOLTS FULL SCALE setting of 1000. The presence of a signal greater than 1 Volt amplitude at some frequency other than 1 KHz necessitates decreasing the input sensitivity to prevent overloading, hence one must increase in proportion the metering circuit sensitivity when examining the 1 KHz signal with the BANDWIDTH switch on one of the more selective settings.

Now that both the amplitude and frequency of the fundamental signal are known, measure the second harmonic content by tuning the frequency to twice the fundamental frequency (approximately 2 KHz). Rotate the MILLIVOLTS FULL SCALE switch counterclockwise until the meter reads up scale. This measure of the second harmonic may now be related to the fundamental signal by expressing its magnitude in percentage of, or decibels below one volt. Similarly, be successively tuning to 3,4, and 5 KHz, the magnitude of the third, fourth and fifth harmonics of the fundamental may be measured.

D. AUTOMATIC MODES

1. AFC

   a. Adjust the instrument as in steps 1 thru 9 of MANUAL OPERATION.

   b. Set the SINGLE/AUTO/RESET switch to RESET position (effective AFC inhibit).

   c. Set MODE switch to AFC position.

   d. When SINGEL/AUTO/RESET switch is switched to either SINGLE or AUTO, the AFC becomes effective.

   The AFC will hold for approximately four times the BANDWIDTH switch setting.

2. TRACK

   a. With MODE switch in OFF position, tune the instrument to a desired signal component as in the

MANUAL OPERATION section.

b. Set RESET/SINGLE/AUTO switch to RESET position.

c. Use the RANGE switch to select the frequency range over which it is desired to track the signal.

d. Choose the bandwidth and meter time constant as required.

Note: In the interest of providing maximum versatility, the bandwidth, sweep, and averaging time controls have not been interlocked such as to always provide maximum accuracy. The operator must therefore consider with care his choice of setting.

The field of waveform and spectrum analysis is both broad and complex. There are, however, several excellent texts and articles published on the subject and therefore no attempt will be made in this short manual to cover it thoroughly. Instead, listed below are a number of basic formulae and notes intended merely to serve as a guide to effective use of the equipment.

a. Sweep or Track rate (Hz) $= \frac{\text{Sweep or Track RANGE}(\Delta f)}{\text{Sweep or Track TIME PER }(\Delta f)}$

$$\text{or } SR = \frac{W}{T}$$

b. The maximum SR, with regard to bandwidth, should not exceed the following formula:

$$SR_{(Max)} = \frac{(BW)^2}{(2)}$$

This refers to the analysis speed limitation imposed by the system bandwidth and can be violated only at the expense of accuracy.

c. The averaging time (METER T.C.) should be selected according to the accuracy requirements of the particular test. In the case of pure random noise the statistical error (e) due to finite filter bandwidth and averaging time may be estimated by:

$$e = - \frac{1}{\sqrt{8BW \quad (TC)}}$$

where: e = Probable error
BW = Effective filter bandwidth
TC = Meter time constant

e. Set the sweep TIME switch to the shortest time which does not light the red indicator lamp.

f. Switch the RESET/SINGLE/AUTO switch to AUTO. The instrument will now track the signal over the range ± (Δf) from the manually set frequency (f).

g. At the rear of the instrument, there is an adjustment labeled "Tracking Threshold Adjust." This adjustment allows the operator to select the signal level at which he wants the tracking to stop. Tune to a fullscale signal and switch to TRACK MODE-AUTO and change signal frequency but remaining within the track range. Set the meter amplitude to the desired level and turn the "Tracking Threshold Adjust" all the way counter-clockwise. Again move the input signal frequency and start turning the "Tracking Threshold Adjust" clockwise until the unit tracks the new frequency.

3. SWEEP

a. Tune to the frequency at which the sweep is to start.

b. Select the bandwidth and metering time constant as required.

c. Select the SWEEP width; 50,100,500, or 1000 or 5000 Hz.

d. Set the SWEEP time; 5,50,500, 5000 seconds (See note under 2.,d.)

e. To initiate the SWEEP, set the RESET/SINGLE/AUTO switch first to RESET then back to either the AUTO or SINGLE positions.

(1) AUTO - Instrument will continuously scan the selected frequency range.

(2) SINGLE - Instrument will make one scan, stopping at the top of the selected frequency range. The unit will then maintain this tuning until manually detuned or reset.

4. SEARCH AND TRACK

a. The instrument is adjusted as in the SWEEP mode of

operation with the exception that when it finds a signal, it will automatically switch to a track mode of operation. The "TRACKING THRESHOLD ADJUST" is also applicable to this mode of operation. (see 2.,g.)

Note that, as in the SWEEP mode, the instrument scans upward through a given range increment, whereas once a signal has been found, the instrument will track both + and - from dial setting by that same range increment.

5. EXTERNAL

In this mode of operation a ±5 V control voltage applied to the EXTERNAL input, at the rear connector of the instrument, will electronically tune the instrument by the RANGE increment (Δf) selected, ± from the tuned frequency (f).

E. PHASE MEASUREMENTS

An extremely useful feature of the Model 304TDL is its capability of supplying analogs of both the real and imaginary portions of the input signal when the specimen under test is excited by the BFO. The advantage of this feature is, that if these two voltages are simultaneously plotted against one another, a polar diagram will result, from which the phase response characteristics of the specimen may be determined. The information can be displayed on either an oscilloscope or an X-Y recorder and the specimen may range from a simple network to a complex electro-mechanical system. Furthermore, the testing can be performed manually or automatically depending on the setting of the SWEEP controls.

1. ACCURACY

No attempt has been made to normalize the phase response of the basic Model 304TDL itself. However, the system phase shift is quite linear with frequency and therefore it can be readily subtracted from the total. Another method more suitable for incremental phase measurements would be to make the deisred plot using an X-Y recorder and calibrated paper, then on the same paper, plot the system phase shift. Mechanical normalization can result in accuracies of a fractional degree.

2. EXAMPLE

Consider measuring the phase response of a bandpass filter centered at 1 KHz and having a bandwidth of 100 Hz.

a. Zero the meter.

b. Connect the BFO to the filter input and connect the filter output to the input terminal of the Model 304TDL.

c. Tune to 1000 Hz and set the BANDWIDTH to 100 Hz.

d. Adjust the BFO to the desired level, keeping it as high as is practical.

e. Adjust the input attenuators and meter sensitivity controls such that the meter reads up-scale.

f. With no signal input, establish the X and Y axes on the paper, adjust the recorder sensitivity, and set the pen at the origin.

g. Connect the outputs of the Model 304TDL to the recorder inputs, J to X and R to Y. With the pen lifted, make a dry run to check equipment connections, sensitivities, etc. The final test can then be made by scanning the spectrum of interest either manually or automatically.

A. THEORY OF OPERATION

The Model 304TDL is basically a dual conversion hetrodyne receiver having a 10 KHz first IF and a zero center frequency second IF.

The variable oscillator is a voltage controlled oscillator producing an output variable from 10 to 15 KHz. It is extremely stable and linear, and enables the instrument to be electronically swept over its whole range by an internal ramp in the SWEEP mode. In the AFC, TRACK, and SEARCH & TRACK modes a phase detector controls the variable oscillator enabling the instrument to track a moving signal.

Referring to the Block Diagram, the incoming signal goes through a step attenuator and source follower into a low pass filter which removes frequencies above 5 KHz. The signal is then mixed with the output of the 10 to 15 KHz variable oscillator. The difference frequency is passed through the 10 KHz first IF to a pair of second modulators. The two second modulators are driven 90° out of phase by a two-phase 10 KHz crystal oscillator. The difference frequencies are then passed through a pair of four-pole maximally flat active low pass filters with selectable cutoff frequencies of 0.5, 5, and 50 Hz. Since the center frequency of the second IF is zero (DC), and the difference signals can go plus and minus, the resultant bandwidths are 1, 10 and 100 Hz. The low frequency filtered signals from the two channels are then chopped at 10 KHz, again 90° out of phase, and recombined in a summing circuit. The summed signal is amplified and rectified, and drives the meter and meter analog.

Phase information can be obtained from the DC outputs of the R and J channels. The R channel balanced modulator is driven from the same phase of the two-phase 10 KHz crystal oscillator as the BFO output modulator. Thus a signal from the BFO output, of low enough frequency not to have phase shift introduced by the two low pass filters in the circuit, will produce a DC output from the R channel, and none from the J channel, which has been chopped at 90° out of phase. If phase shift is introduced between the BFO output and the input to the first modulator, the R output will decrease and the J output increase until, at 90°, there will be no R output and maximum J output. In this way the Model 304TDL can separate the real from the imaginary parts of a voltage, derived from a device driven by the BFO output.

The BFO output is a constant amplitude signal of exactly the frequency to which the instrument is tuned. It is

obtained by mixing the 10 KHz fixed oscillator with the 10 to 15 KHz variable oscillator and taking the difference frequency. Unwanted higher frequency modulation products are removed by a low pass filter.

The RESTORED signal output is a filtered replica of the input signal exactly equal in frequency and proportional in amplitude. It is obtained by mixing the summed 10 KHz signal with the variable oscillator output and taking the difference frequency.

In the AFC and TRACKING modes a phase detector compares the phase difference between the second (RØ,JØ) and fourth (Rn,Jn) poles of both of the low pass filters and produces a DC voltage of proper amplitude and polarity to tune the variable oscillator, so that the desired signal is in the center of the pass band. Control of the variable oscillator by the output of the phase detector is inhibited unless the signal is in excess of the tracking threshold, determined by a rear panel adjustment. The output from the phase detector is attenuated in accordance with the bandwidth, tracking range, and tracking time in use.

B. CIRCUIT DESCRIPTION

1. ±10 VOLT SUPPLIES, +5 VOLT SUPPLY, +160 VOLT SUPPLY SCHEMATIC T-7813

The -10 volt supply has as its reference CR108. The error signal between this reference and the midpoint of the voltage divider formed by R107 and R108, with its padding resistor R109, is amplified by IC101, which drives the pass transistor Q103. The +10 volt supply receives its reference voltage from the -10 volt supply through a voltage divider formed by R111 and R112. The error amplifier IC102 drives the pass transistor Q104. The +5 volt supply is regulated by a simple two-transistor amplifier Q101 and Q102, obtaining its reference from the +10 volt supply through the voltage divider R103 and R105. These supplies are all adjusted at the factory and should require no further calibration. The +160 volt supply is required to operate the gas discharge tubes in the digital readout.

2. LAMP CIRCUIT - SCHEMATIC T-7812

The green MODE lamp DS101 lights whenever the instrument is in any mode except manual tuning. The red SWEEP lamp DS102 lights when the BANDWIDTH switch, the SWEEP TIME switch, and the SWEEP RANGE switch are set to positions that would give misleading results if the instrument were used under these conditions.

3. INPUT, LOW PASS FILTER, PRE-AMPLIFIER, and FIRST MODULATOR - SCHEMATIC T-7801

The input step attenuator has an input impedance of 1 megohm and is followed by an FET source follower as an impedance converter. The source follower drives the low pass filter, which is followed by the variable gain control, and the pre-amplifier, IC101. The pre-amplifier drives the balanced modulator Q103 and Q104, a complementary pair, which are driven in phase by the push-pull complementary drivers Q105 and Q106. The balanced output from this modulator is fed to the transformer input of the 10 KHz first IF filter.

4. BANDPASS FILTER, STEP ATTENUATOR and IF LOG AMPLIFIER - SCHEMATIC C-7802

The output of the 10 KHz bandpass filter feeds amplifier IC101, which in turn feeds the MILLIVOLTS FULL SCALE step attenuator, and the log compressor amplifiers, IC102 and IC105. The IF output amplifiers, IC103 and IC104, are driven directly from the step attenuator in the linear mode of operation and from the log compressor amplifiers in the log mode. The log compressors are controlled by the meter circuit.

5. FIXED OSCILLATOR and SECOND MODULATOR - SCHEMATIC T-7803

The 10 KHz fixed oscillator frequency is derived from a 40 KHz crystal oscillator, IC101. The 40 KHz output is divided by four by IC102. The circuitry is so arranged as to obtain two 10 KHz outputs precisely 90° out of phase. The 10 KHz quadrature signals are available at J102 and J103 to drive another Model 304TDL or a Model 1304L, as slave units. With S103 in the SLAVE position, the instrumen may be driven as a slave analyzer from another Model 304TDL. The 10 KHz quadrature signals are used to drive the balanced second modulators, Q104 and Q106, through Q103 and Q107. The outputs of the balanced modulators are fed to the two lo pass filters through their appropriate bandwidth switches.

6. LOW PASS FILTERS AND AMPLIFIERS - SCHEMATIC C-7804

The R and J Channel filters and amplifiers are identical. Each of the filters consists of two two-pole RC active networks with capacitors selectable by the BANDWIDTH switch. The first section has a gain of approximately 50. A balanced FET input stage, Q103, is used to minimize DC drift in the amplifier IC101. The second section has a gain of slightly more than 1. The gains of the two amplifier sections are adjusted so that the overall response is that of a maximally flat or

Butterworth filter. Separate outputs are taken from both the second (ø) and the fourth (N) poles of each filter. The phase difference between these points is later measured in the phase detector and used to control the variable oscillator in the AFC and TRACK modes. The gain in these channels is pre-set at the factory and should not be changed.

7. CHOPPER and PHASE DETECTOR - SCHEMATIC T-7805

The outputs obtained from the second (Rø,Jø) and fourth (Rn,Jn) poles of both the R and J channels are chopped at 10 KHz in the quadrature choppers Q101-Q102, and Q103 - Q104, and the phase difference between the second (ø) and fourth (N) poles of both low pass channels are compared in the phase detector IC105. The DC output of the phase detector is filtered and amplified in IC106, where a necessary DC offset is also introduced. The amplified DC output is then either passed or stopped by Q105, which is controlled by the threshold adjustment on the metering circuit board. The chopped, summed and filtered output from the fourth poles (Rn - Jn) of the R and J channels are passed on to the metering circuit through the MILLIVOLTS switch S102 and BANDWIDTH switch S104. In the 6500 Hz bandwidth position, the output from the pre-amplifier is fed directly to the metering circuit board, by-passing all intervening circuitry.

8. METER CIRCUIT - SCHEMATIC C-7806

The meter amplifier consists of isolation amplifier IC101 and rectifier amplifier IC102. The rectified output drives the threshold detector IC103, which controls the AFC and TRACKING modes. The rectified output also feeds the meter time constant circuit, which in turn feeds the impedance converter Q102 and the DC amplifier IC104. The output of IC104 controls the log compressor amplifiers and drives the log meter circuit in the log mode of operation, and drives the meter and meter analog directly in the linear mode. Q103 clamps the meter analog to ground during retrace of sweep or when the switch is in the RESET position.

9. LOG METER CIRCUIT - SCHEMATIC T-7807

The log amplifier IC101, which is driven from the meter circuit, drives scaling amplifier IC102. The output of the scaling amplifier is connected, along with the output of the meter circuit, to the MILLIVOLTS FULL SCALE switch, S102C, where the selected output is connected to the meter, through R116 and R117, and to the meter analog through the divider R114 and R115.

10. SWEEP GENERATOR - SCHEMATIC T-7808

The switching functions and resistor values on this schematic are somewhat complex and need not be explained in detail. The resistance values have been optimized to give proper tracking, sweep, and sweep length capabilities. The sweep generator itself consists of Q101 and IC101, which form a Miller Integrator that charges C103 linearly with time. When the voltage across C103 reaches a value equal to a reference voltage set by R128, IC102 is tripped, discharging C103 through Q102, provided that the sweep selector switch in set in the AUTO mode. If the switch is in the SINGLE mode, the sweep will merely rise to its maximum value and remain there until a RESET or AUTO mode has been set. In the RESET mode C103 will remain permanently discharged by Q102.

11. IMPEDANCE CONVERTER - SCHEMATIC T-7809

Here again, the resistance networks associated with the MODE, SWEEP RANGE, and BANDWIDTH switches provide optimum performance in the sweeping and tracking operations of the instrument. IC101 is an impedance converter which provides a variable reference voltage to IC102. IC102 also receives a differential reference voltage from the frequency control potentiometer on the front panel. IC102's output is used to drive the frequency analog and to control the frequency of the variable oscillator.

12. VARIABLE OSCILLATOR and DIVIDE BY 40 CIRCUIT - SCHEMATIC T-7810.

The variable oscillator is basically an extremely stable, free-running multi-vibrator, Q101 and Q108. Its frequency is controlled from the impedance converter by linearly varying the current through Q102 and Q107. This current varies the discharge time of the timing capacitors C103 and C104. Q103 and Q106 function as non-linear collector loads to keep the dissipation in the circuitry at a minimum. Since multi-vibrators are often hard to start, there is a selfstarting circuit consisting of Q104 and Q105. The output of the multi-vibrator is isolated and amplified by Q109 to provide maximum stability. Since the Model 304TDL presents new frequency data four times per second, the oscillator operates at a frequency of 400 to 600 KHz to run the digital circuitry. The output of the oscillator is divided by 40 by IC101 and IC102 to provide the 10 to 15 KHz variable oscillator output. This output is also available at J105 to run other slave analyzers.

13. BFO AND RESTORED - SCHEMATIC T-7811

The output of the variable oscillator drives the complementary pair Q101 and Q102, which drive the balanced modulator Q103 and Q104. The other input to the modulator comes from the fixed oscillator for BFO output or the meter circuit for RESTORED output. The difference frequency is fed through two active low pass filters which remove the unwanted modulation products. A variable output attenuator is placed between the two sections.

SECTION 4 - CALIBRATION

A. GENERAL

The components and transistors in the MOdel 304TDL are conservatively rated and should provide long and trouble free service. If, however, the instrument has been damaged and recalibration or alignment is required, the following instructions should be followed explicitly,or the instrument returned to the factory. Instructions are given on the Warranty page as to the procedure to be followed, should it be necessary to return the instrument for any reason.

Although the Model 304TDL is a complex instrument, trouble shooting can readily be done in sections as indicated in the BLOCK DIAGRAM.

DO NOT change any adjustment without a thorough knowledge of the circuit and the functions of the adjustment.

Standard transistor servicing care should be used throughout. Transistors can be easily damaged with large transient voltages. Therefore, take great care not to short any terminals when making measurements on the printed circuit boards.

In soldering to the printed circuit boards, have the iron only hot enough to make a rapid clean solder joint. DO NOT apply any force that would tend to push the copper away from the board.

B. REMOVAL FROM CASE

1. Remove the four screws from the rear of the case.

2. Slide the instrument gently out of the front of the case.

C. CHANGING INPUT VOLTAGE

This instrument has been designed to operate from a 117V AC or a 234V AC power source. The plate on the rear of the instrument near the power cord indicates the voltage and frequency at which the instrument should be operated.

Should it be desired to change the input voltage:

1. Remove the voltage plate and move the switch under the plate to the required voltage. Replace plate (one side for 117 volt and the other for 234 volt operation).

2. Change the fuse. For 117V AC operation the fuse should be 1/4 amp. slow blow; for 234V AC operation, the fuse should be 1/8 amp. slow blow.

D. CALIBRATION

1. General

The Model 304TDL is a precision instrument, the accuracy of which depends, in large part, on critically balanced DC circuitry. The circuits in turn are designed to operate over a moderate temperature range. However, the instrument cannot cope with thermal shocks or transients which cause differential temperatures to occur between individual components. The closed-box environment provided by the Model 304TDL's case affords its circuits both thermal-transient and electrostatic shielding, thereby resulting in more stable operation. During calibration similar protection may be required in the interest of accuracy. It is also recommended that the "extender boards" supplied with each instrument be used in the case of those adjustments which cannot be made without removing the circuit board. If a circuit board must be temporarily removed from its socket, or if the unit is momentarily turned off, be sure to allow the instrument time to restabilize before making further adjustments.

Following is an outline of the setup procedure. It is important that the adjustments be made in the prescribed order, inasmuch as some of them depend upon completion of the previous ones.

CAUTION

Included in this procedure are a number of adjustments which require the actual selection and installation of components. These particular adjustments are intended to be made ONLY on new assemblies or those which have received catastrophic damage, necessitating a major overhaul. An asterisk indicates factory selected components on the schematics.

Those adjustable controls not covered in the "Calibration Procedure" should NOT be adjusted. These are set at the factory during initial calibration and will not require further adjustment.

2. Adjustment Procedure Outline

a. Frequency Determinants

(1) Power Supplies

(2) Variable Oscillator and Impedance Converter

(3) Fixed Oscillator

(4) Sweep Circuits

b. Signal Channel

(1) Meter Zero Adjustments

(2) R/J Channel Balance

(3) Calibrate Gain Circuit

(4) Check Systems Gain

3. Test Equipment Required

a. VOM - Avometer or equivalent 20,000 Ohm/Volt

b. D.C. Voltmeter - 0.1% Accuracy

c. Oscillator - 10 Hz to 100 KHz, 1 Volt output

d. VTVM - HP 400D or equivalent

e. Oscilloscope - Tektronix 503 or equivalent

f. Oscilloscope - 50 MHz response with low-capacitance probe

g. Frequency Counter - Range 500 KHz, accuracy 0.1%.

h. Decade Attenuator - GR 1450 or equivalent

4. Initial Setting of Controls

METER ZERO Controls	Midrange
METER T.C.	.1
MILIVOLTS FULL SCALE	1000
BANDWIDTH	100 Hz
FINE Control	Midrange
Frequency Readout	0000.0
METER MULTIPLIER	X1
Variable Control	CALIBRATED
MODE Switch	OFF
SWEEP RANGE	5000
SWEEP TIME	5 SECONDS
Sweep Function	RESET
BFO/RESTORED	BFO

Variable Control	Fully Clockwise
Rear Panel MASTER SLAVE Switches	Both in MASTER position.

5. Calibration of Frequency Control Circuits

NOTE: ALLOW INSTRUMENT TO WARM UP FOR 15 MINUTES BEFORE ATTEMPTING THE FOLLOWING PROCEDURES.

a. POWER SUPPLIES Assy #6710-Test Equipment Item b.

(1) Monitor the minus 10 Volt line with D.C. Voltmeter connected between emitter of Q103 and ground. Should read minus 10 Volts ±100 millivolts. If necessary, select R109 for correct reading.

(2) Monitor the plus 10 Volt line between emitter of Q104 and ground. Should read plus 10 Volts ±100 millivolts. The plus supply reference is obtained from the minus supply and needs no adjustment.

(3) Monitor the plus 5 Volts supply at the collector of Q102. If necessary, adjust R102 for plus 4.8 to 5.25 Volts output.

(4) Check the plus 160 Volt supply with a voltmeter. This voltage will be approximately 165 to 175 Volts at normal ine voltage.

b. SWEEP GENERATOR Assy #7359-Test Equipment Items b and g.

Front panel controls as "Initial Setting" except MODE switch to SWEEP position.

(1) Monitor SWEEP ANALOG with DC Voltmeter at front panel connector. DC voltage should be zero volts, ±1 millivolt. Set SWEEP function to SINGLE sweep and adjust R128 for plus 5 Volts, ±10 millivolts after completion of sweep (5 sec.)

with parts pointing down. R128 for lefthand ADJ.

c. IMPEDANCE CONVERTER Assy #7360

(1) Turn MODE switch to OFF. Monitor the "Frequency Analog" on pin 7 of J101 with DC Voltmeter. Set FINE frequency tuning control to midrange and the COARSE tuning control approximately 1/4 turn clockwise from lower end stop, until DC Voltmeter reads zero Volts, ±25 MV. Switch MODE switch to SWEEP and allow instrument ot sweep to the end of a SINGLE sweep. Adjust R125 to give 5

with parts pointing down. R125 for righthand ADJ.

362
143
219

Volts, ±10 millivolts output.

(2) Check sweep ranges for designated widths within ±5%.

(3) Check SWEEP TIME as designated, within ±20%. NOTE: Since the sweep circuit generates a very linear ramp voltage (0 to ± 5 Volts) the total ramp time may be extrapolated by measuring only a portion of the total sweep voltage, perhaps 1 or 2 Volts.

d. VARIABLE OSCILLATOR Assy #6707-Test Equipment Items b and g.

Front Panel Controls as in "initial setting"

R106 factory selected

(1) Monitor the "Variable Oscillator" frequency with counter at connector on rear panel. Frequency should be 10 KHz, ±25 Hz, when front panel readout reads zero. If necessary CHANGE ~~adjust~~ R106 for correct frequency. Should it be necessary to change R106, allow circuit time to regain thermal stability before re-checking.

* = put on extender board only ADJ on board

*(2) Turn tuning control to vary frequency analog to 5 Volts, ±50 millivolts. Adjust R116 to display 5000 Hz on frequency counter. front panel

e. FIXED OSCILLATOR Assy #7501

(1) Monitor "Fixed Oscillator" frequency at connector marked "R" on rear panel, with frequency counter. Frequency should be 10 KHz ± 0.5 Hz. This is a crystal controlled oscillator and no adjustment is available. "R" channel output leads "J" channel output by 90 degrees.

6. Calibration of the Signal Channel

Front panel controls as in "Initial Setting" except: Tune the frequency readout to 1 KHz and set MILLIVOLTS FULL SCALE switch to 3.

a. Low Pass Filter Assy #7504

In order to obtain both the required range and resolution of the METER ZERO controls, it is necessary to have both coarse and fine adjustments for each channel.

(1) Adjust the front panel METER ZERO controls to midrange.

with equip right side up, "R" TP ADJ is above the "J" TP ADJ.

= put 7505 on extender board

(2) Monitor "R" and "J" channel low pass outputs (on rear baseboard) with D.V.M. or oscilloscope. Adjust R109 on each channel for zero volts, ±20 millivolts. These are TP's on the board #7504 plugs into. These are NOT BNC connectors.

*b. Phase Detector Assy #7505 - Test Equipment Items c,d, and e. Front panel controls as in "Initial Setting".

(1) Connect the oscilloscope to "Carrier" test point (on rear baseboard). With no input applied, null carrier output by adjusting METER ZERO controls on the front panel.

(2) Apply a 1 KHz signal of 1 Volt amplitude to the input of the Model 304TDL and tune the instrument to the signal.

c. Tracking Adjustment - Set front panel controls as follows:

BANDWIDTH	100 Hz
MODE SWITCH	SEARCH AND TRACK
SWEEP TIME	5 SECONDS
SWEEP RANGE	5000 Hz
SWEEP FUNCTION	RESET

(1) Connect "R" channel low pass output (test point on top of rear baseboard) to the oscilloscope horizontal input (DC coupling). Connect the "J" channel low pass output to the oscilloscope vertical input (DC coupling). Adjust "X" and "Y" sensitivities to 0.2 millivolts/cm. Apply a 1 KHz signal, 1 Volt amplitude to the Model 304TDL input and tune the instrument to obtain a slowly rotating circular Lissajous Pattern.

NOT BNC →

(2) Change sweep function to SINGLE. Adjust R132 for "phase lock" on signal. (R132 shown on Chopper and Phase Detector schematic).

NOTE: Although the instrument is not intended to be a phase lock system, careful adjustment of METER ZEROs, and phase detector may enable phase locking in the tracking modes.

(3) Change sweep function to RESET and adjust manual tuning to a frequency just greater than one bandwidth above zero frequency. Apply a signal to the 304TDL input and set the sweep function to AUTO.

The instrument will now start to search upwards in frequency and lock onto a signal of sufficient amplitude whose frequency is within the programmed

search range.

d. System Gain Calibration

Front panel controls as in "Initial Setting".

with cover off gain is bottom ADJ. on #7506 (MTR. CKT)

(1) Calibrate the gain of the overall system by applying a 1 KHz signal of an exact 1 Volt amplitude to the input. Tune the frequency to 1 KHz. Adjust "Gain Cal" control on the rear panel for one volt at meter analog.

try to O lock as in step C.1. before making gain ADJ.

(2) Switch BANDWIDTH to 6500 Hz and adjust R142, (pot is located on the lower baseboard near the pre-amp section) for full scale meter reading. (R142 is shown on the Chopper and Phase Detector schematic).

JUST ABOVE #6706 when looking at bottom of equip. setting on its right side →

e. Log Circuit Circuit

(1) Apply a 1 volt RMS signal, and tune for full scale reading in 1000 MV range.

bottom of 3 ADJ when right side up →

(2) Switch to LOG mode and adjust R108 on the Log Meter Circuit Board, Assy #7540, for a one volt meter analog.

IS IN THE MIDDLE →

(3) Attenuate the input signal level by EXACTLY 40 DB and adjust R110 for .5 volts at the analog.

(4) Return to the full scale input level and readjust R108 for a one volt analog. This completes the adjustment.

SEMICONDUCTOR LEGEND

Changes and improvements in the semiconductor products available for commercial use necessitate type changes from time to time. To eliminate confusion and costly paperwork, many of these changes will be covered in the following legend. The purpose of this legend is to acknowledge the fact that the type number on a semiconductor found in a piece of equipment will not necessarily correspond with the type number given on the schematic diagram.

The legend is not intended to be an interchangeability list although in many cases good quality components* within a given category may be substituted with acceptable results. Normally, replacements should be made using components having the same type number as the component being replaced.

Those components bearing an asterisk on the schematic diagram are factory selected components and should be obtained from Quan-Tech.

*It should be noted that the incoming inspection procedure followed at Quan-Tech includes noise screening on most semiconductors.

TYPE NO. ON SCHEMATIC	TYPE NO. IN EQUIPMENT
1N482A	1N648, 1N3604, 1N3605
1N703	1N748, 1N749
1N709	1N753
1N2859	1N3253, 1N3254
1N2862	1N3254
1N3253	75A4, 1N3254
1N3254	75A4
1N3604	1N3605, 1N482A, 1N648
1N3605	1N3604, 1N482A, 1N648
TIS73	TIS75
TI480	2N1613, 2N3566, 2N3643 A322, 2N929
TI494	2N1613, 2N3566, 2N3643, A322, 2N929
UC240	2N4869, 2N3819
2N270	2N3644, 2N3250, 2N3251
2N396A	2N414, 4JX1G759, 4JX1D653, 2N3644, 2N3250, 2N3251
2N414	2N396A, 4JX1G759, 4JX1D653, 2N3644, 2N3250, 2N3251
2N929	A322, A324, A642, 220N2, 2N3566, 2N3643, 2N2219

TYPE NO. ON SCHEMATIC	TYPE NO. IN EQUIPMENT
2N1304	2N1306, 2N3566, 2N3643, A322
2N1306	2N1304, 2N3566, 2N3643, A322
2N1515	2N3644, 2N3250, 2N3251
2N1613	2N3566, 2N3643, A322, 2N2219
2N2219	D16C33, 220N2, A322, A324, A642, 2N3566, 2N3643
2N2603	2N3250, 2N3251
2N3250	2N3251, 2N3644
2N3251	2N3250, 2N3644
2N3566	2N3643, A322, 2N929, 2N2219
2N3643	2N3566, 2N2219, A322, 2N929
2N3644	2N3250, 2N3251
2N3819	TIS73, TIS75, TIS59, 2N4869, UC240,
2N4869	2N3819, UC240

SCHEMATIC LEGEND

k – 1000

– Screw Driver Adjustment

– Front Panel Control

* – Factory Select

Unless Otherwise Specified:

All Resistances in Ohms

All Resistors 1/2 Watt

All Capacitances in Microfarads

5/21/71

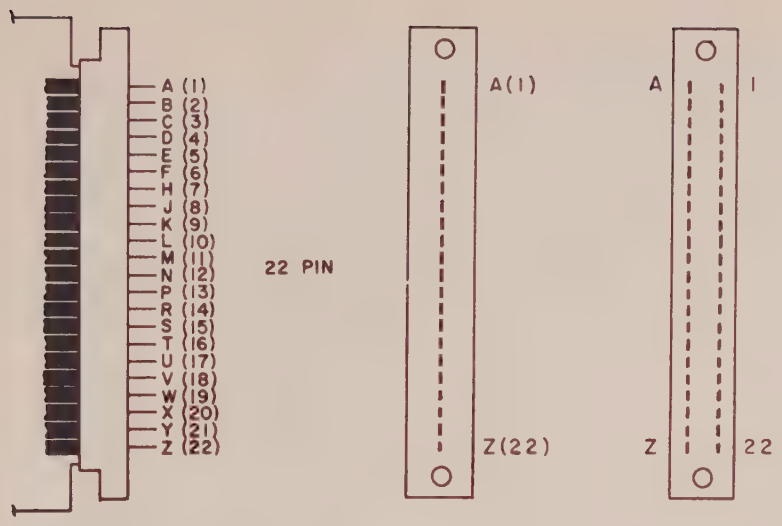


FIG. 1 PRINTED CIRCUIT BOARD LUG IDENTIFICATION

Fig. 1 illustrates the identification and orientation of a printed circuit board and connector utilizing 22 pins.

When a printed circuit board of a lesser number of pins is called for, the same designating sequence shall apply.

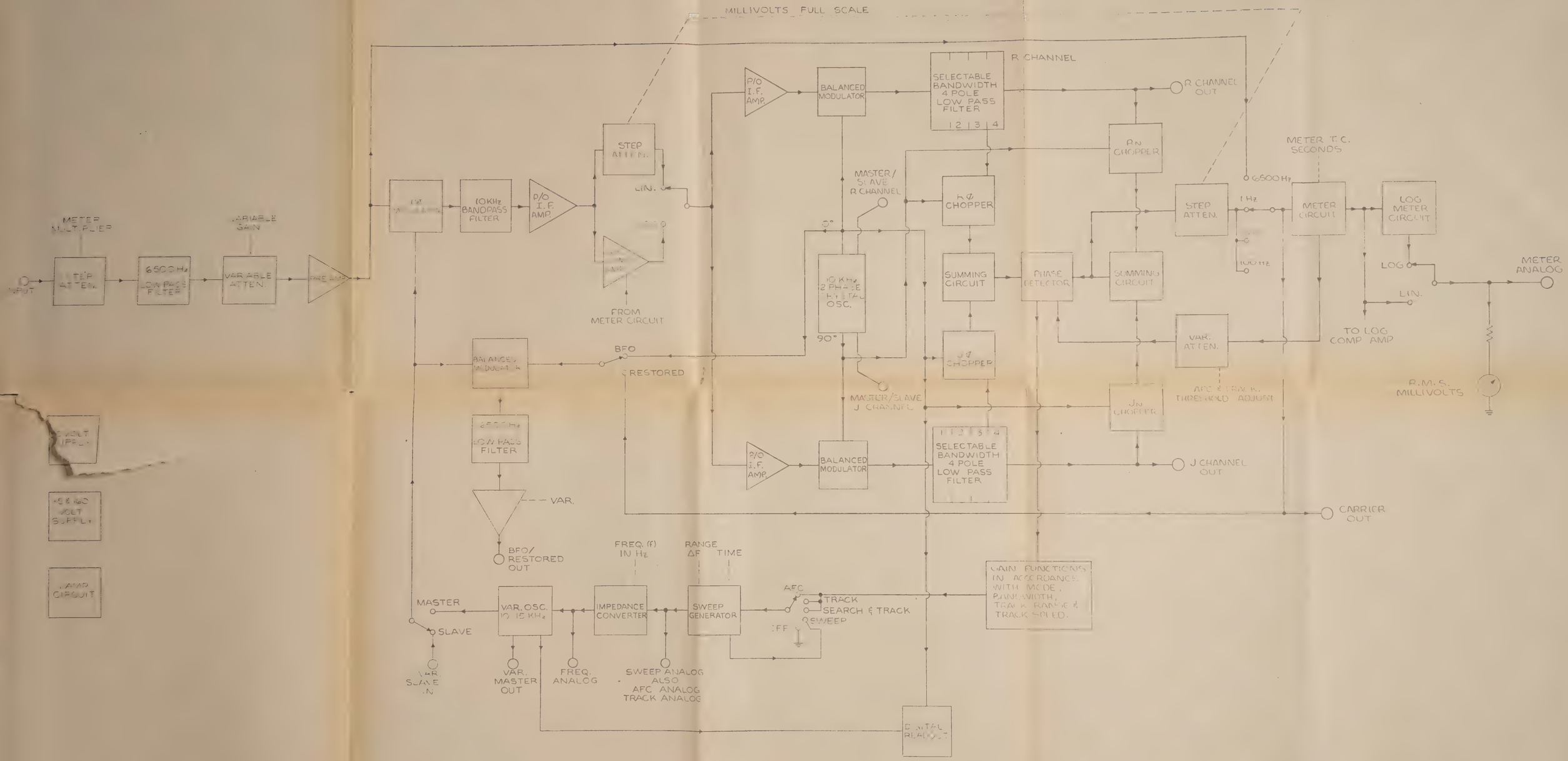
When a single sided copper P.C. Board is used, its pin identification shall be as shown in Fig. 1, and its schematic references shall be A(1), B(2), C(3) etc. The copper side faces the observer when viewed as shown at the left.

When using a double sided copper P.C. Board, its pin orientation shall be as shown in Fig. 1 and its schematic references shall be as follows:

a. (A), (B), (C) etc. signifies that electrical connections are made to lettered side of P.C. Board (A side).

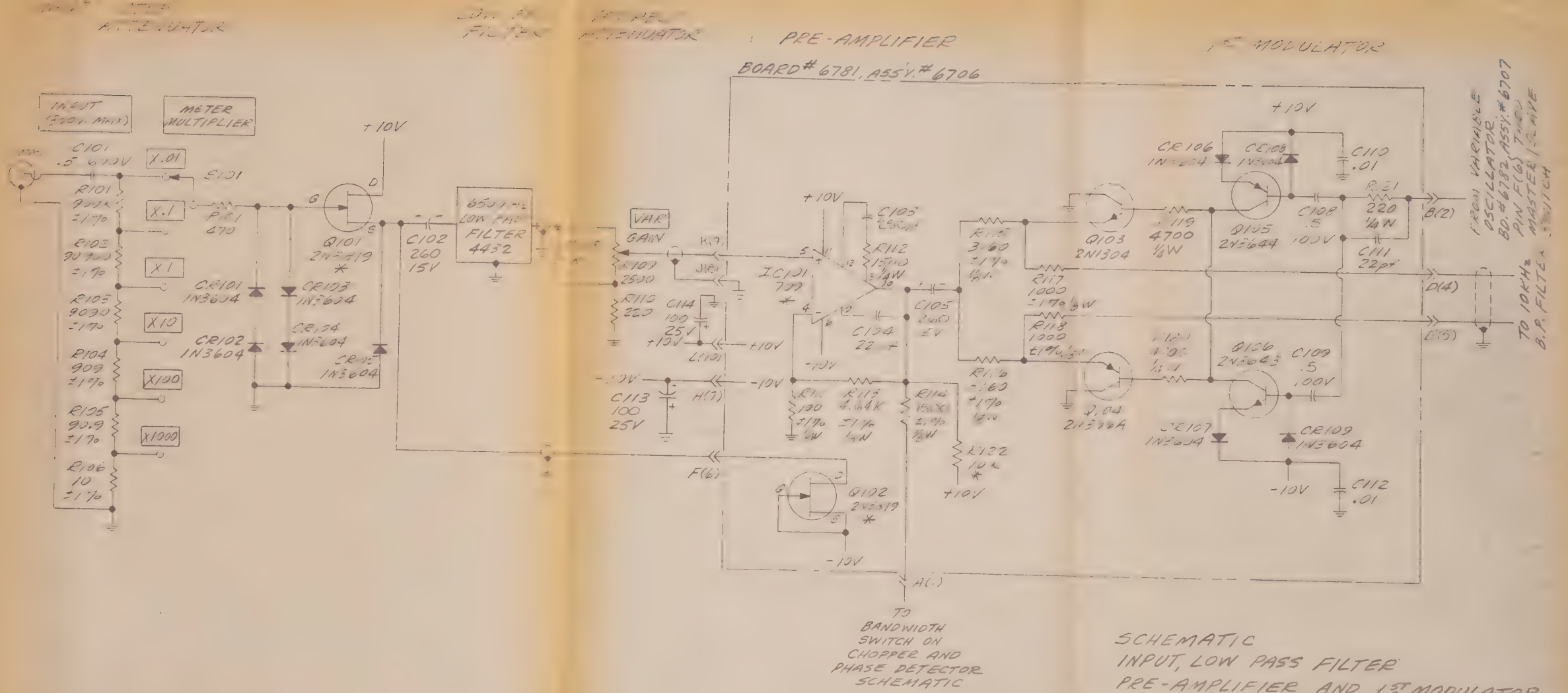
b. (1), (2), (3) etc. signifies that electrical connections are made to numbered side of P.C. Board (1 side).

c. A(1), B(2), C(3) etc. signifies that electrical connections are made to both sides of P.C. Board simultaneously, i.e., A and 1 are schematically connected.

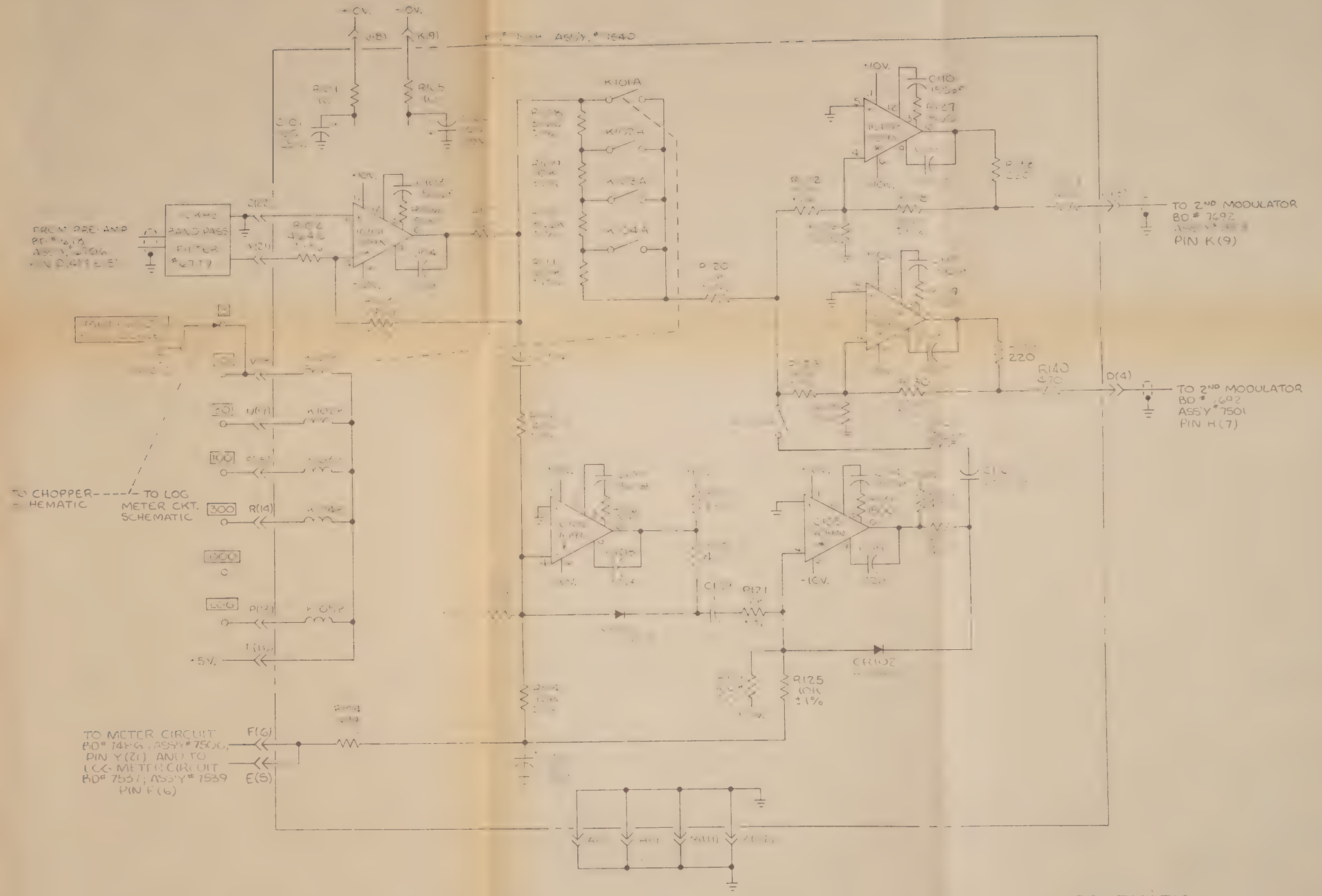


BLOCK DIAGRAM
MODEL 304 TDL

D-7800 A

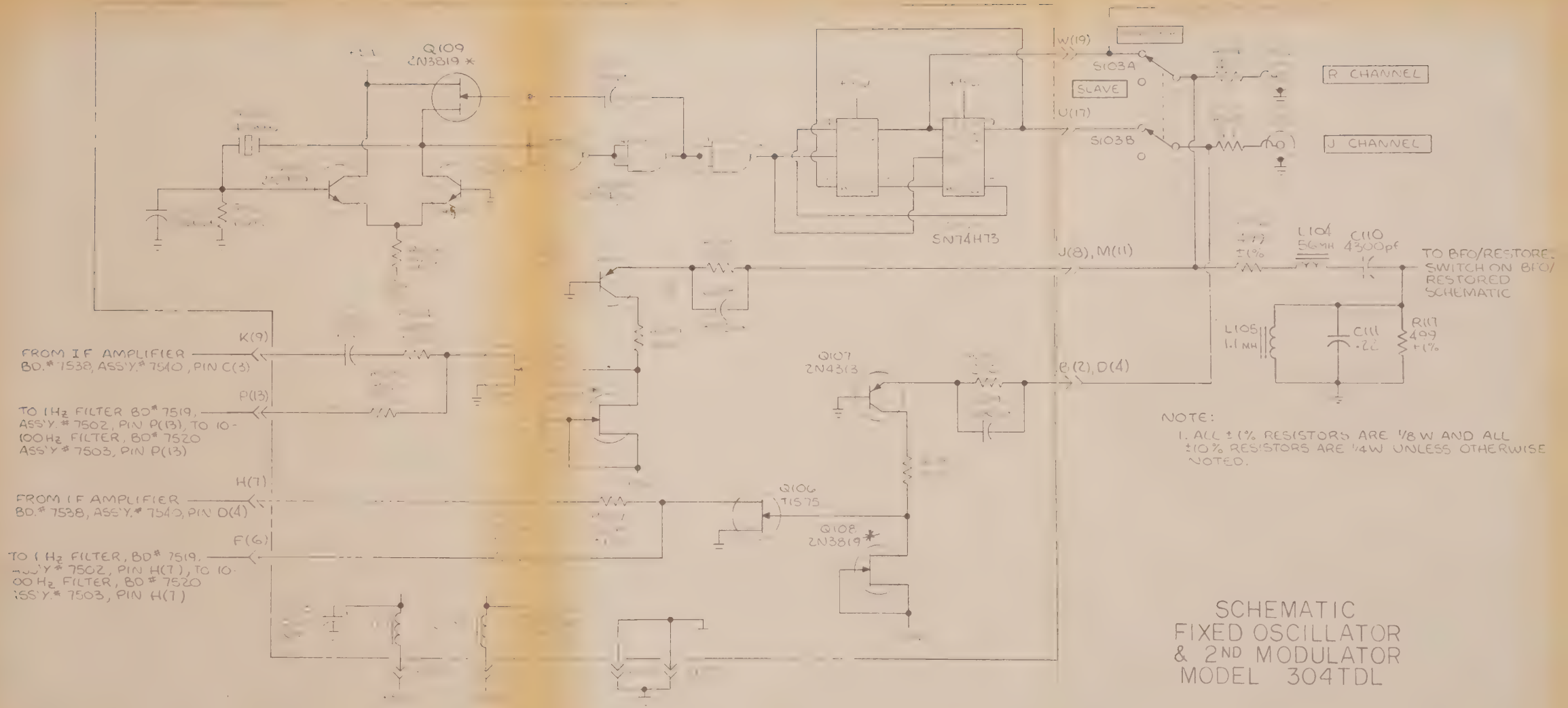


SCHEMATIC
INPUT, LOW PASS FILTER
PRE-AMPLIFIER AND 1ST MODULATOR
MODEL 304-TDL



SCHEMATIC
I.F LOG AMPLIFIER
MODEL 304 TDL

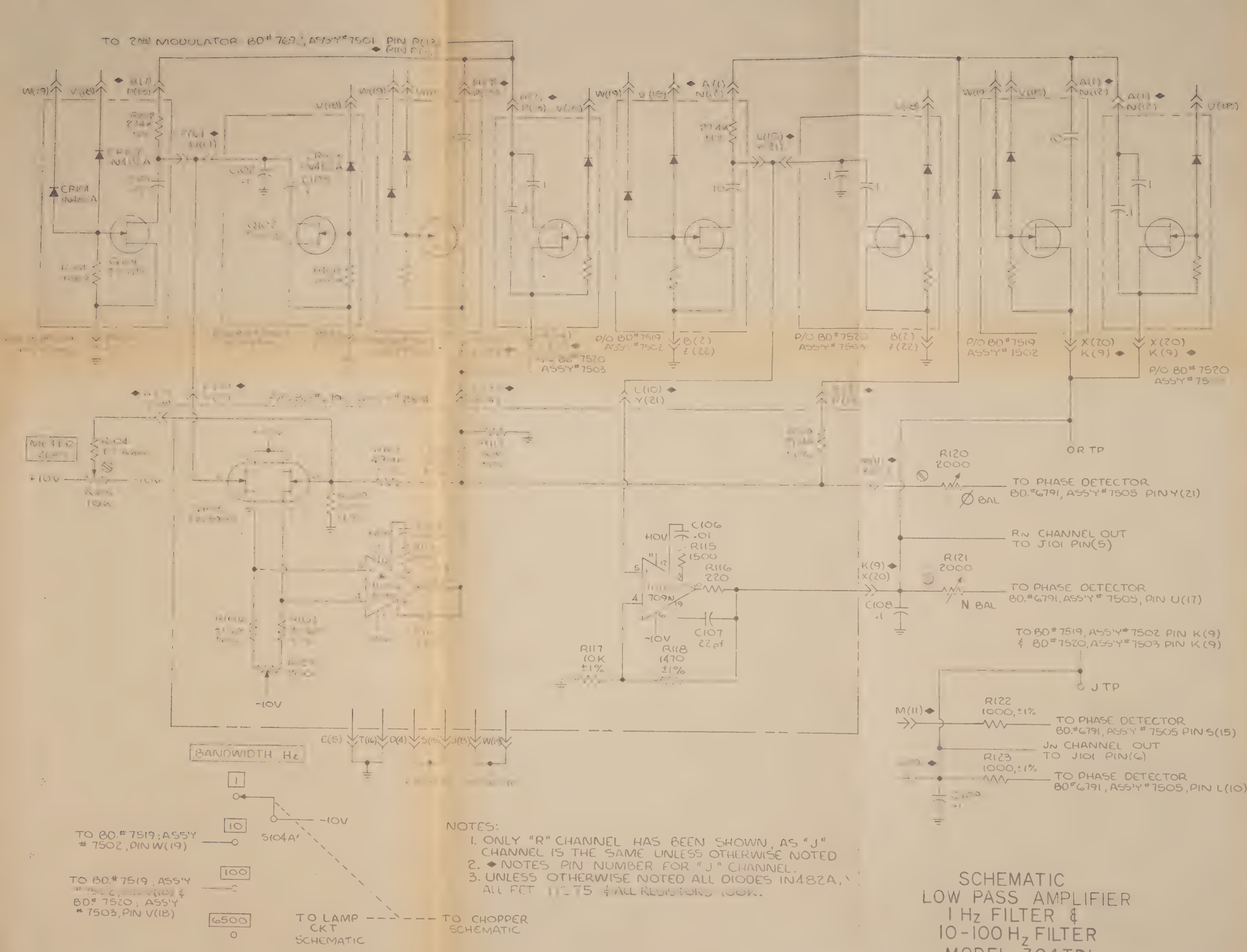
C 7862 A



NOTE:

1. ALL ±1% RESISTORS ARE 1/8 W AND ALL ±10% RESISTORS ARE 1/4W UNLESS OTHERWISE NOTED.

SCHEMATIC FIXED OSCILLATOR & 2ND MODULATOR MODEL 304TDL

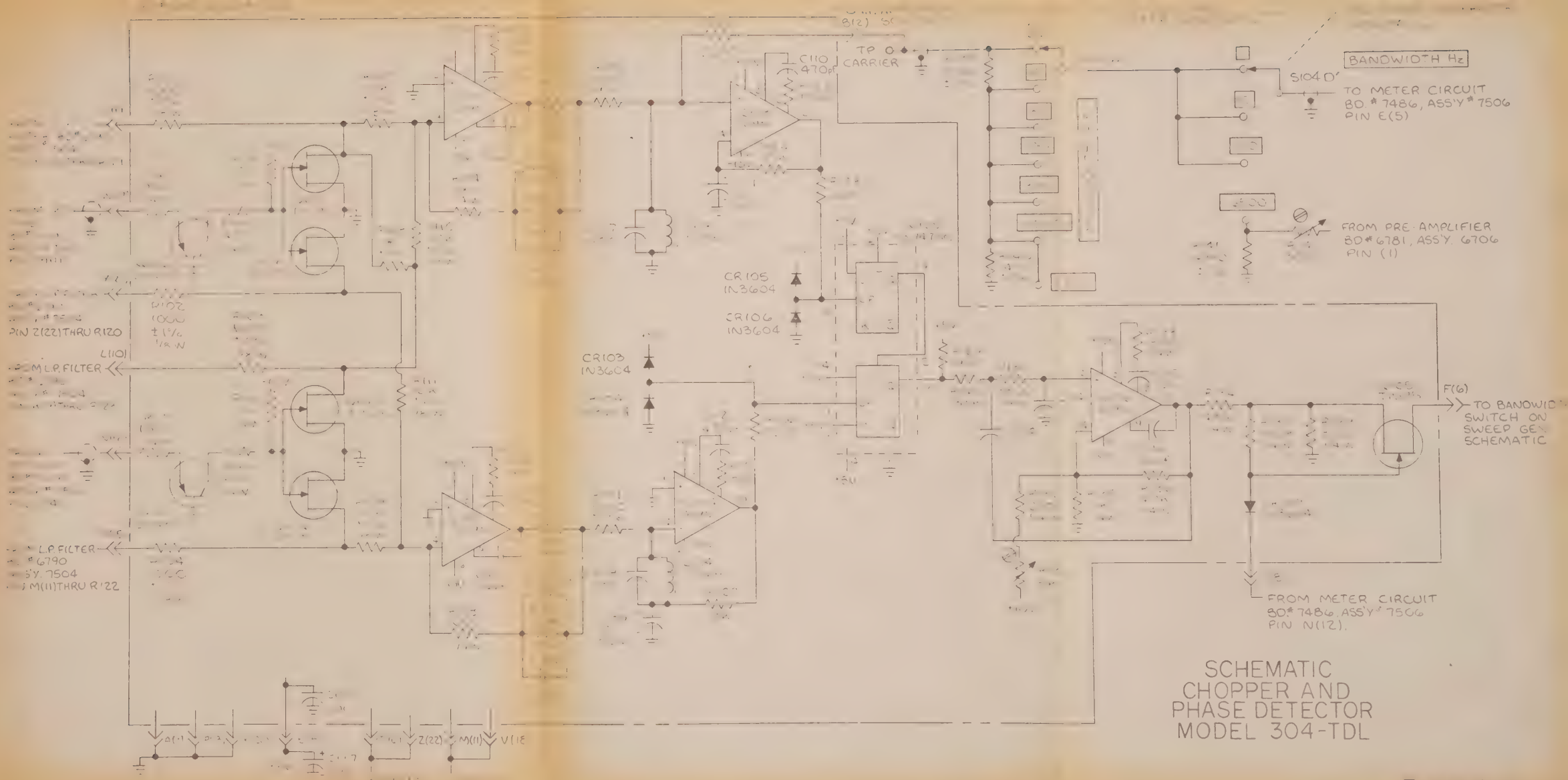


NOTES:

1. ONLY "R" CHANNEL HAS BEEN SHOWN, AS "J" CHANNEL IS THE SAME UNLESS OTHERWISE NOTED
2. ◆ NOTES PIN NUMBER FOR "J" CHANNEL.
3. UNLESS OTHERWISE NOTED ALL DIODES IN482A, ALL FET'S TIL75 & ALL RESISTORS 100K.

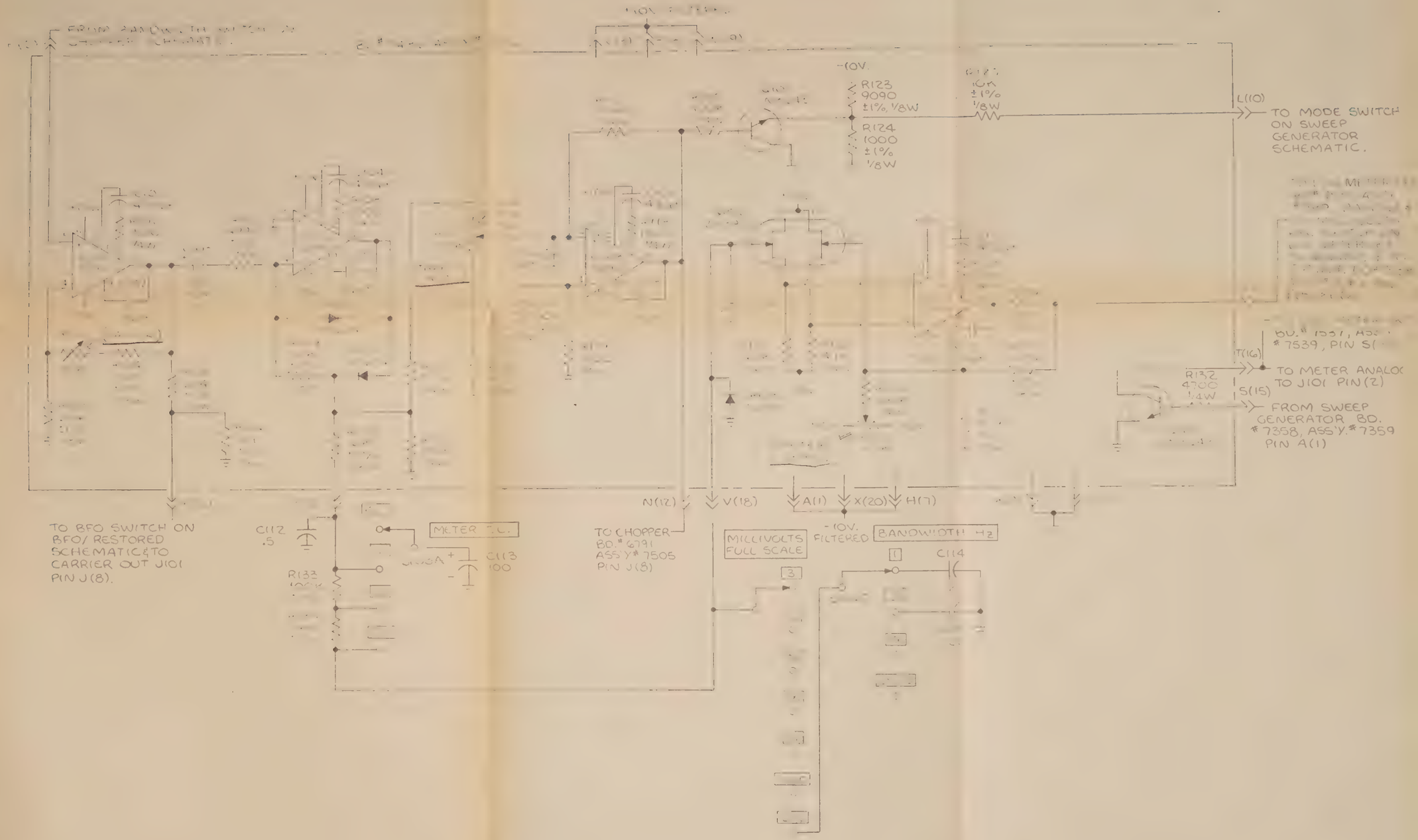
SCHEMATIC LOW PASS AMPLIFIER 1 Hz FILTER & 10-100 Hz FILTER MODEL 304TDL

C-7804 A



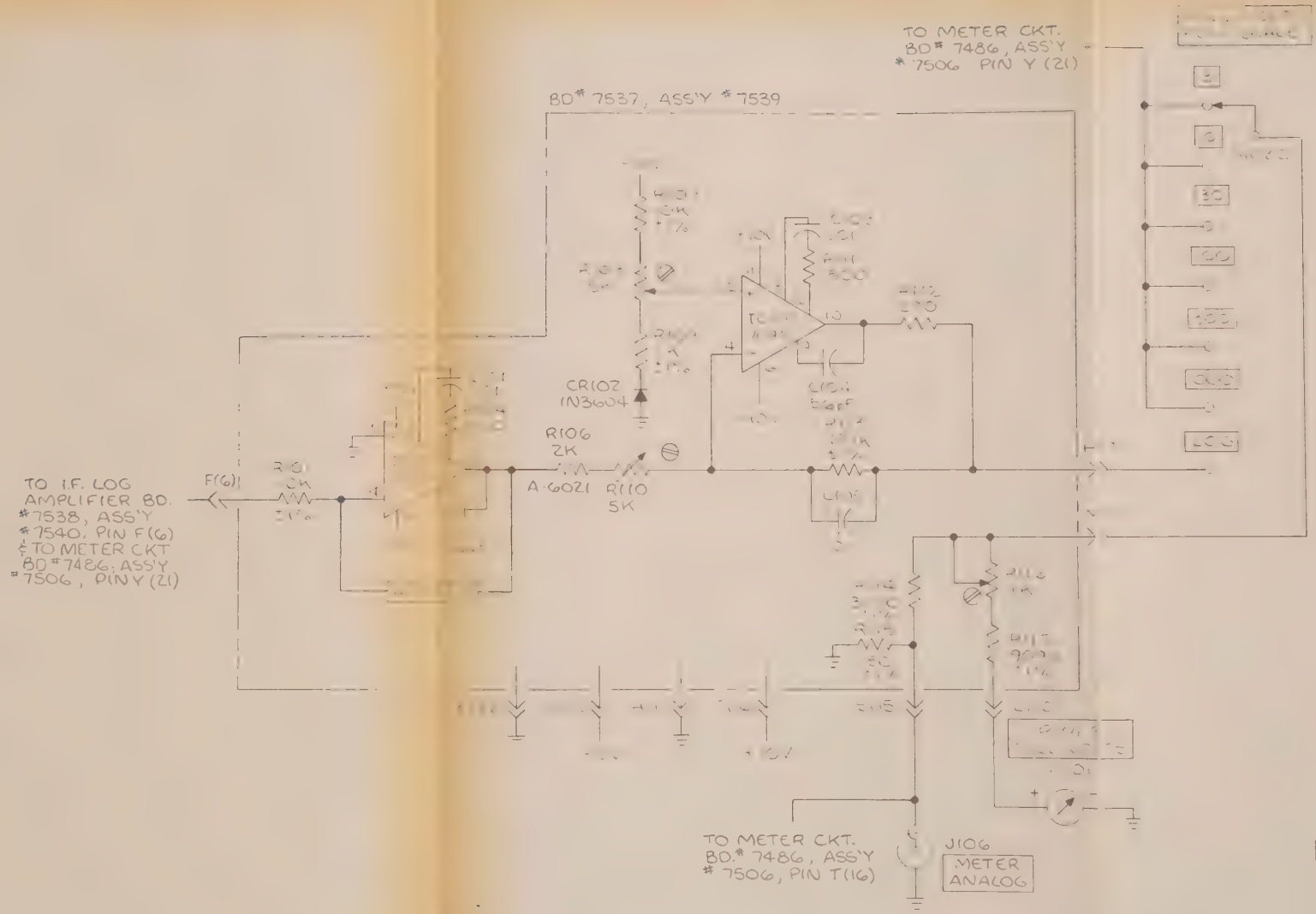
SCHEMATIC CHOPPER AND PHASE DETECTOR MODEL 304-TDL

T-7-5-A



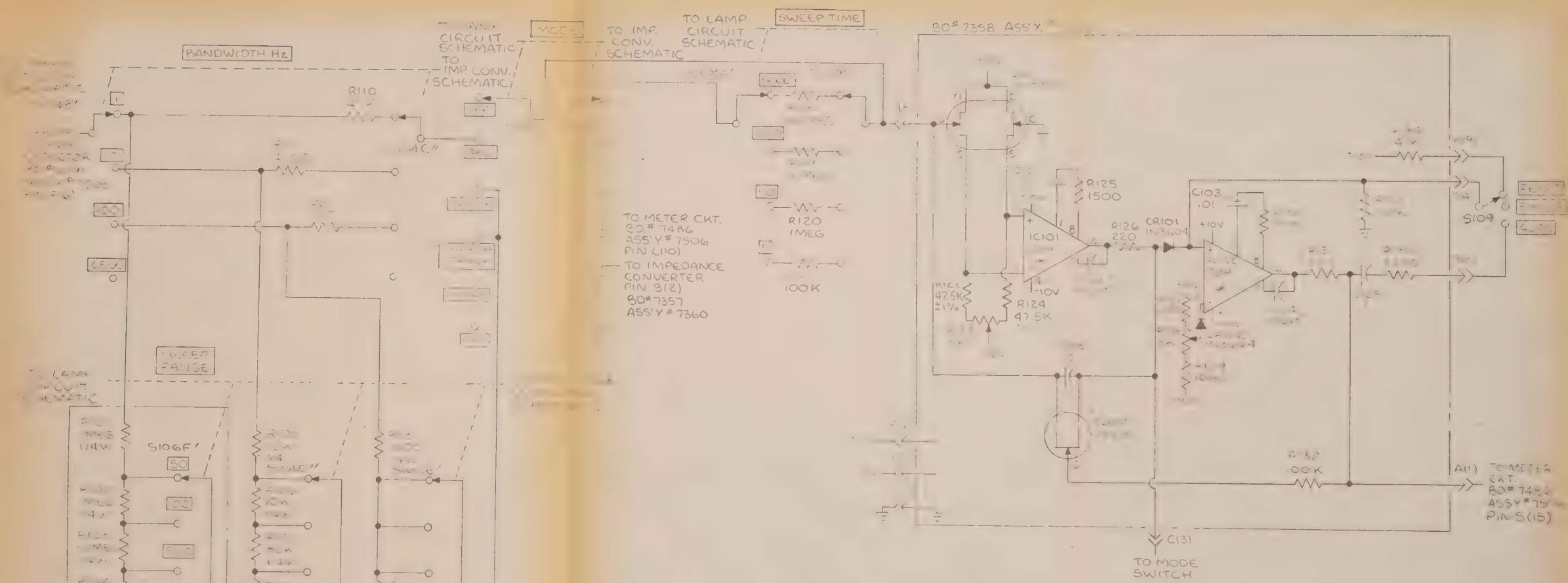
SCHEMATIC
METER CIRCUIT
MODEL 304TDL

C-7-15 A



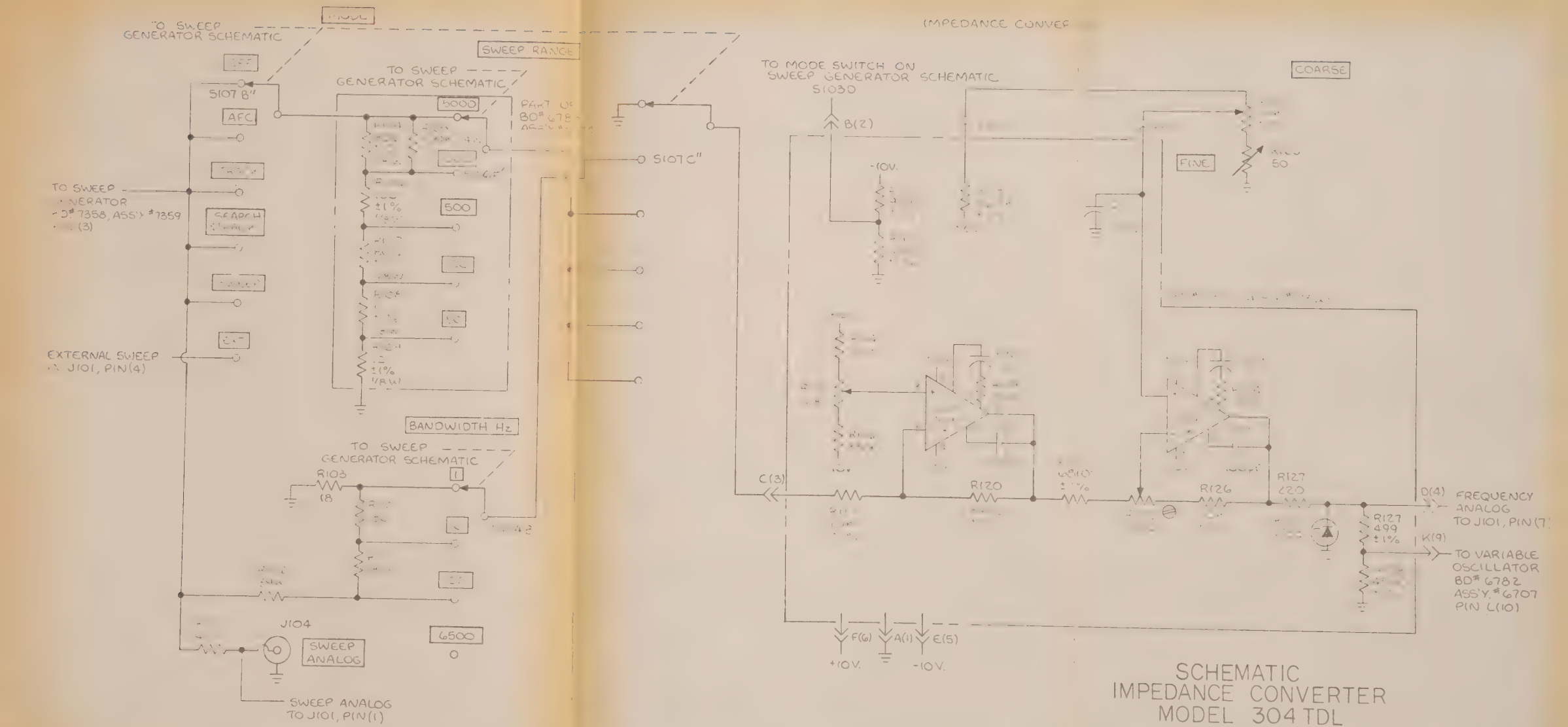
SCHEMATIC
LOG METER CIRCUIT
MODEL 304TDL

T-7807 A

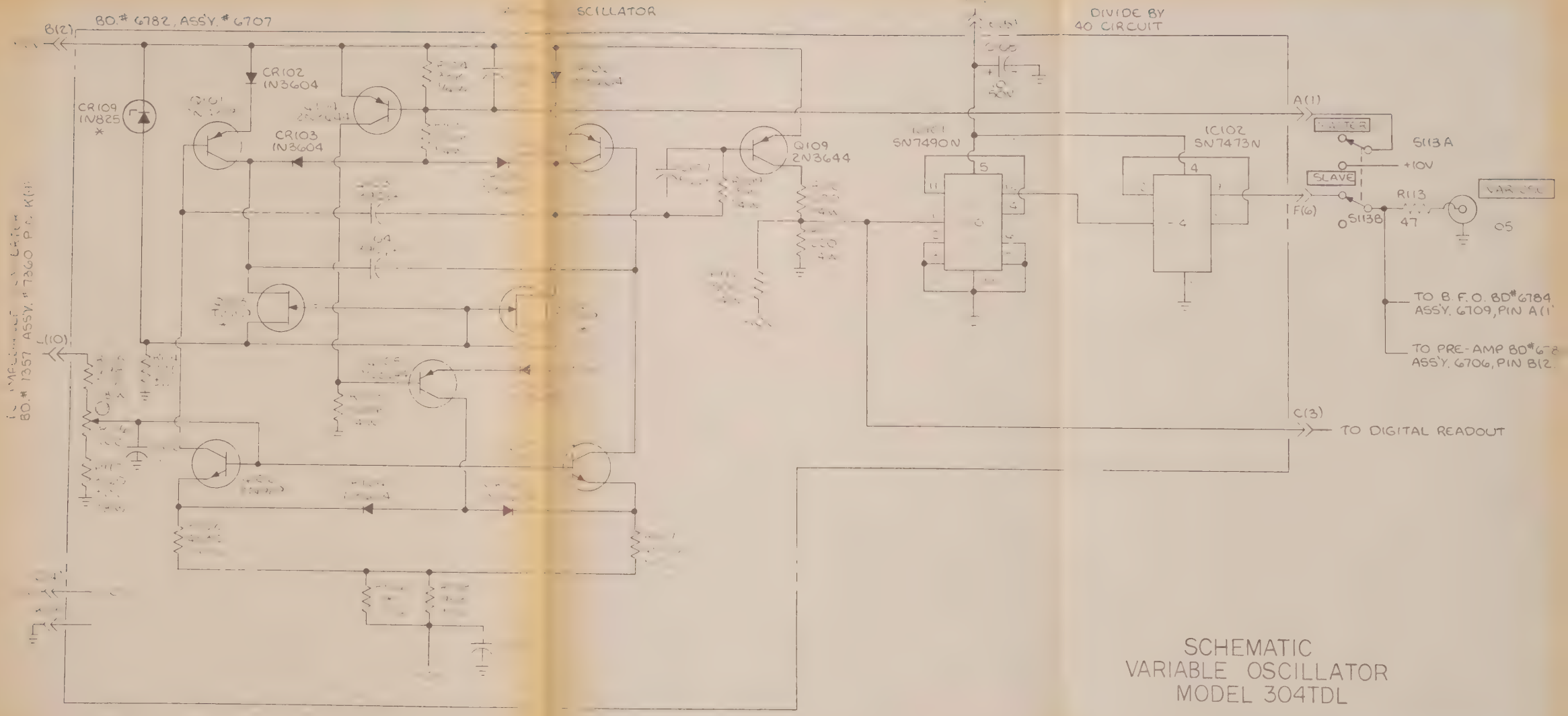


SCHEMATIC
SWEEP GENERATOR
MODEL 304TDL

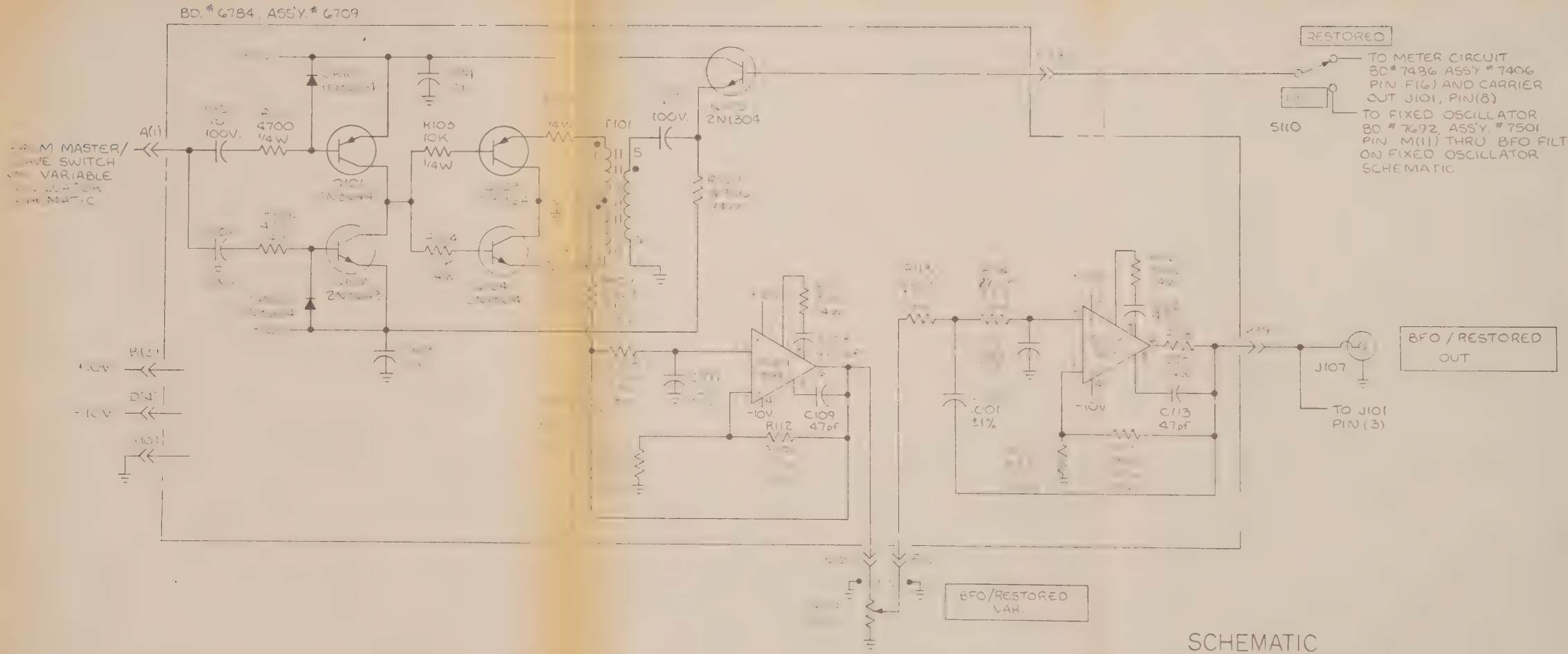
I-7[illegible]-A



SCHEMATIC IMPEDANCE CONVERTER MODEL 304 TDL

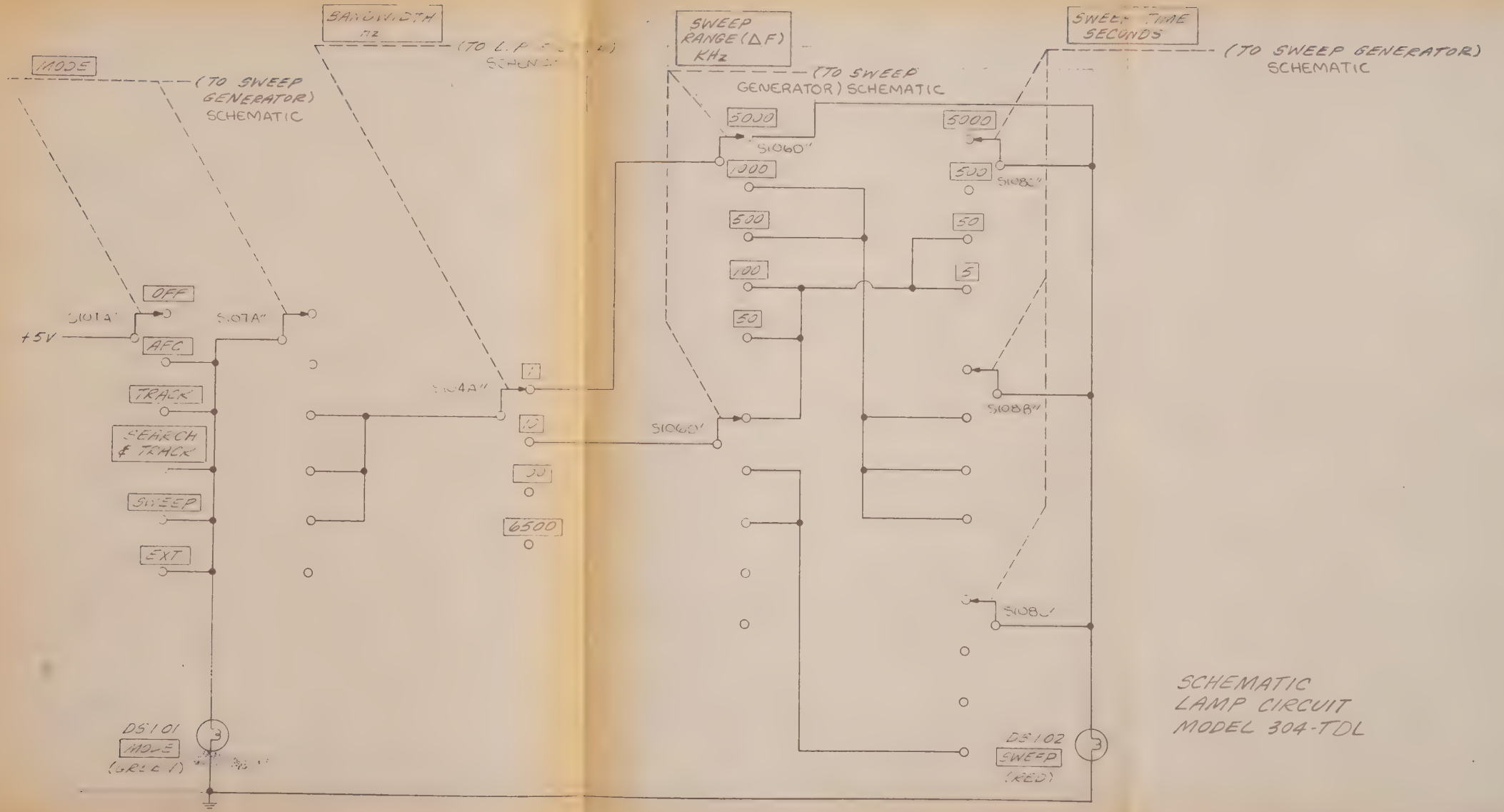


SCHEMATIC
VARIABLE OSCILLATOR
MODEL 304TDL



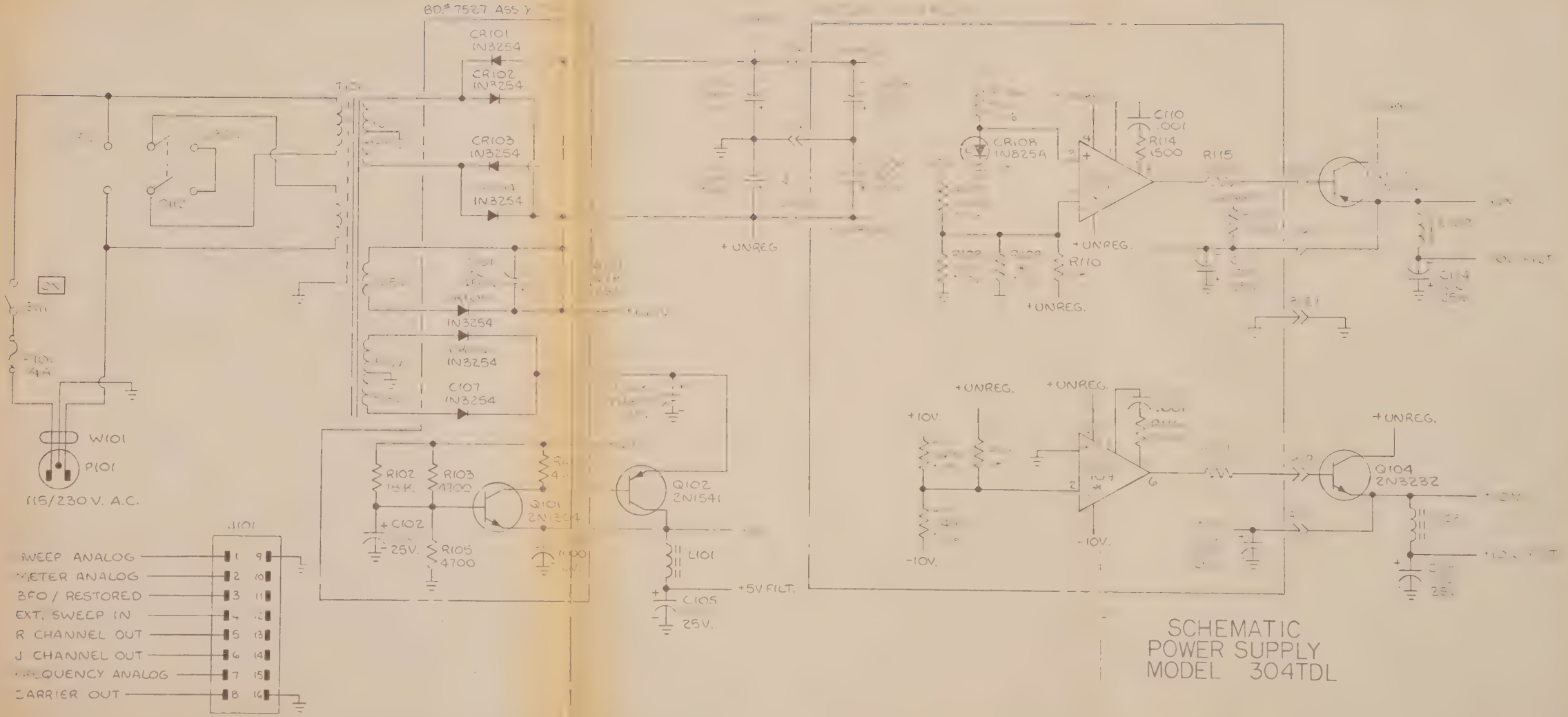
SCHEMATIC
BFO/ RESTORED
MODEL 304TDL

T-784-A



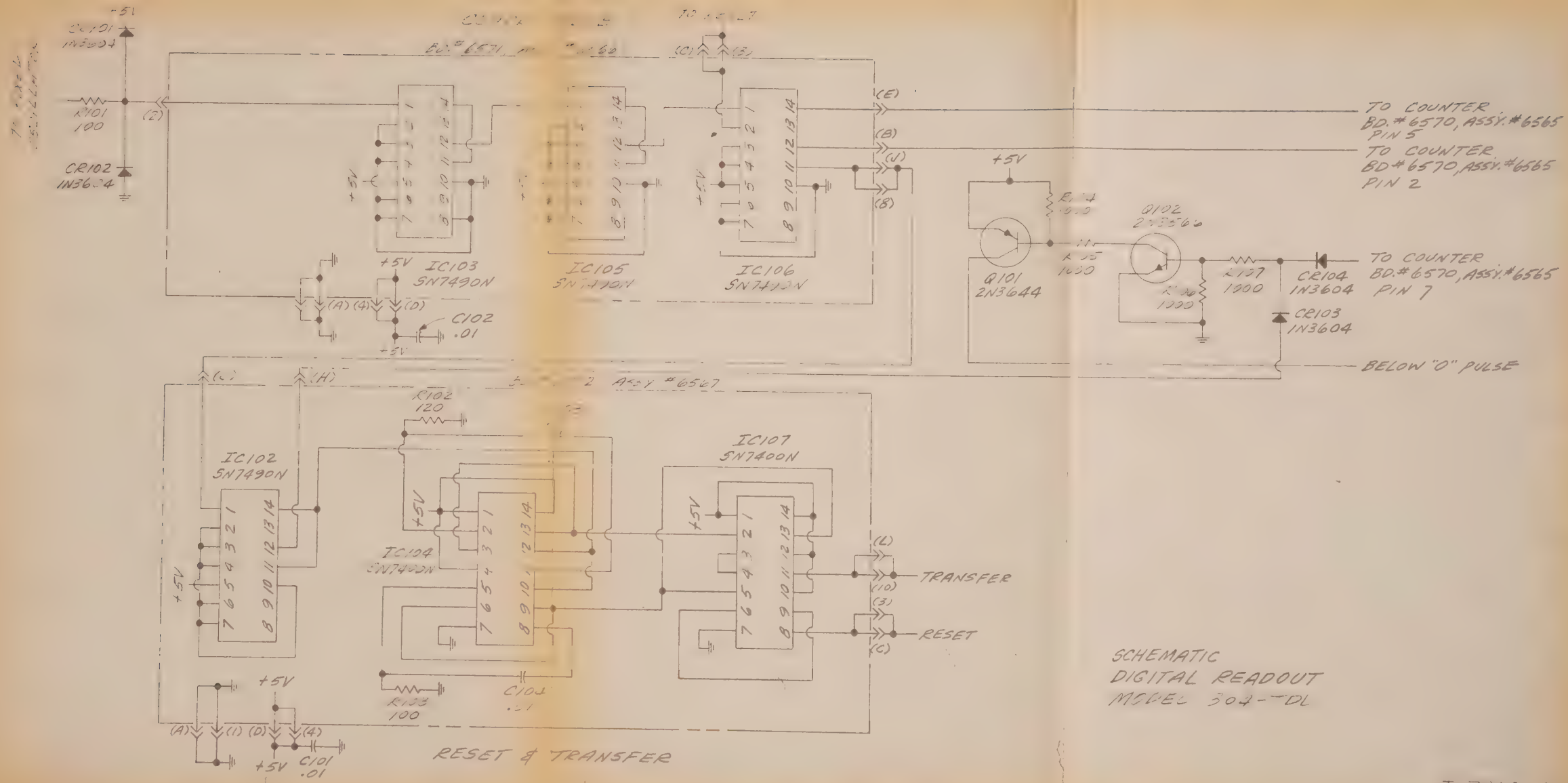
SCHEMATIC
LAMP CIRCUIT
MODEL 304-TDL

T-7512-A



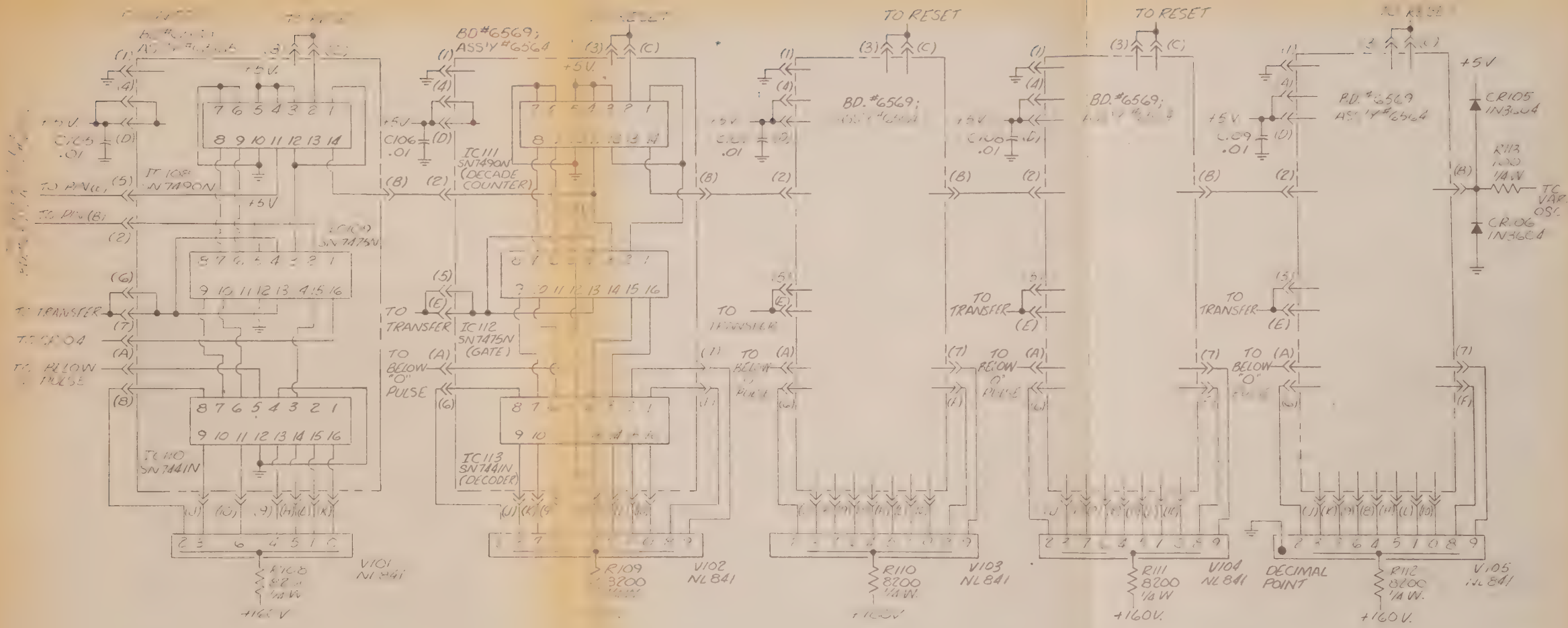
SCHEMATIC
POWER SUPPLY
MODEL 304TDL

T-7913 A



SCHEMATIC
DIGITAL READOUT
MODEL 304-TDL

T-7814 A



SCHEMATIC
DIGITAL READOUT
MODEL 304-TDL

T-7614 A

SHORT FORM CATALOG

Quan-Tech®
Div. of KMS Industries, Inc.

Specialists in Electronic Instrumentation

#3 South Jefferson Road · Whippany, New Jersey 07981
Telephone (201) 887-5508

A Word About Noise Analysis

Since 1957 when it was founded, Quan-Tech Laboratories has specialized in the amplification and measurement of extremely low level signals approaching the theoretical limits of sensitivity. In order to build equipment of this sort it was necessary to select components having the lowest possible electrical noise for use in the most sensitive parts of the circuit. Noisier components were relegated to places where (it was thought) their noise would not interfere with proper operation. These noisy components exhibited a very high rate of failure compared to the quiet ones, so an intensive study of the reasons for these failures was undertaken.

Investigation showed that those components which exhibited excessive amounts of noise (particularly of the "1/f" type) compared to similar units, usually contained some defect or abnormality which could lead to early failure. This was equally true of resistors, transistors, and diodes, even though the failure mechanism might be different for each device.

This discovery led to the development of specific electrical noise measuring instruments for each type of component. Cooperative programs with manufacturers have proved beyond doubt that noise measurements, properly applied, can locate many types of failure-prone components before they are placed in the circuit, with resultant cost saving and increased reliability. Even manufacturers of such fiercely competitive items as automobile radios, electronic organs, and hearing aids have found noise screening cuts costs and improves product quality.

If you haven't already investigated the benefits of noise analysis, both for reliability and for very low noise applications, why not contact us or our local representative and get the full story?

Quan-Tech
DIVISION OF KMS INDUSTRIES, INC.

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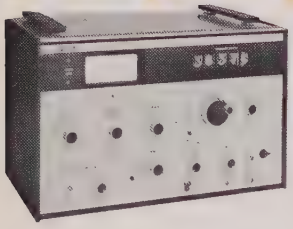
Quan-Tech Division of KMS INDUSTRIES, INC.

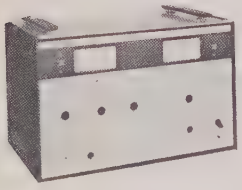
▪ WAVE AND SPECTRUM ANALYZERS



Model 304-TDL

TRACKING WAVE AND SPECTRUM ANALYZER

Frequency Range: 1 Hz to 5 KHz. **Frequency Readout:** 5 place electronic digital display. **Bandpasses:** Flat topped, 1, 10, and 100 Hz at —3 db, Broadband, 10 to 6500 Hz. **Skirt selectivity:** 24 db per ½ bandwidth. **Sensitivity:** Logarithmic, 0 to 70 db, 10 MV to 100 V F.S., Linear, 30 μV to 300 V F.S. **Tuning:** Electronic, 6 selectable modes: manual, manual plus AFC. Automatic sweep, tracking, search and track, external control. **Outputs:** BFO, restored signal, analogs of meter reading, frequency setting and automatic sweep, phase outputs for phase plot Built-in Master-Slave capability for multi-channel analysis systems. **Price:** $3875

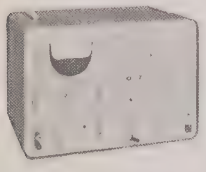


Model 1304-L

For use with Model 304-TDL in multi-channel phase locked analyzer systems. The Model 1304 has a built-in phasemeter but no tuning controls. Mechanical impedance and transfer function analysis is simplified. Bandwidths and signal amplitude analysis characteristics are the same as the Model 304-TDL. **Price:** $2850

CROSS SPECTRAL DENSITY ANALYZER **Model 3304**

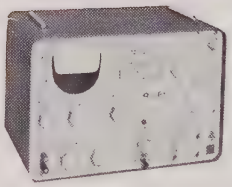
For use with the Models 304-TDL and 1304-L for computing cross spectral density. Values of Cxy, Qxy and Gxy are presented on front panel meters. **Price:** $2450



Model 304

LOW FREQUENCY WAVE & SPECTRUM ANALYZER

Frequency range: 1 Hz to 5 KHz; **Bandpasses:** 1, 10 & 100 Hz, selectable at front panel; **skirt selectivity:** 24 db per ½ bandwidth; **Voltage range:** 30 μV to 100 V FS; down to .03 μV FS with accessory Model 206B preamplifier (see last page); **Tuning:** Manual or automatic; Internally supplied electronic sweep of total frequency range or of discrete portions; provision for external sweep; **Frequency calibration:** Linear 1 Hz per division; **Outputs:** BFO, restored signal, sample of automatic sweep, analogs of meter reading and frequency setting, phase output for phase plot on X-Y recorder. **Price:** $2700



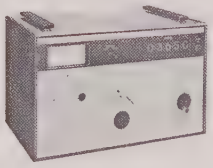
Model 305

TRACKING WAVE AND SPECTRUM ANALYZER

Frequency Range: 10 Hz to 50 KHz. **Bandpasses:** Flat topped 10, 100 and 1000 Hz at — 3 db. **Sensitivity:** 30 μV to 300 V F.S. **Tuning:** Manual, manual plus AFC, automatic sweep, tracking, search and track, external. **Outputs:** BFO, restored signal, analogs of sweep, amplitude, frequency and phase. Master-Slave capability for multi-channel analyzer systems. **Price:** $2800

Model 305-D

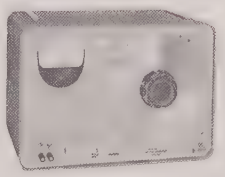
Same as Model 305 except 5 place electronic digital frequency readout instead of frequency dial. **Price:** $3350



Model 350

HIGH FREQUENCY WAVE ANALYZER

Frequency Range: 10 KHz to 10 MHz. **Frequency readout:** 5 place electronic digital display. **Bandpasses:** 4 KHz and 40 KHz at —3 db. **Sensitivity:** 10 μV to 10V, continuously variable precision capacitive attenuator with input overload indicator. **Outputs:** BFO, rectified signal envelope, and meter analog. **Price:** $2495



Model 303

WAVE AND SPECTRUM ANALYZER

Frequency Range: 30 Hz to 100 KHz, semi-log frequency dial. **Bandpasses:** 10, 30, 100 and 1000 Hz at —3 db (100 and 1000 Hz bandwidths flat topped). **Sensitivity:** 100μ V to 300 V, F.S. **Price:** $1700

WAVE AND SPECTRUM ANALYZER **Model 2156**

Similar to Model 303 except: **Frequency Range:** 10 Hz to 30 KHz. **Bandpasses:** 3, 10, 30, 300 Hz. **Price:** $2375

WAVE AND SPECTRUM ANALYZER **Model 2223**

Similar to Model 303 except: **Frequency Range:** 10 Hz to 200 KHz. **Bandpasses:** 10, 100, 750, 1000 Hz. **Price:** $3525

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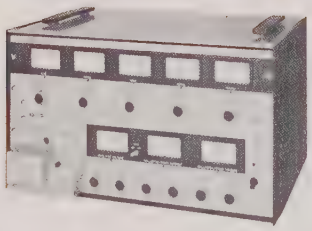
Quan-Tech
Division of KMS INDUSTRIES, INC.

- **NOISE TEST SYSTEMS FOR TRANSISTORS, FET AND LINEAR I.C.'S**
- **RESISTOR AND DIODE NOISE TEST SETS**



Model 2173C -2181

TRANSISTOR-F.E.T. NOISE ANALYZER

The most versatile unit available. Measures noise current and voltage at 10 and 100 Hz, 1, 10, and 100 KHz simultaneously. **Noise spectral density range:** 3 to 3000 nanovolts FS. **Base resistance range:** 0, 500, 1K, 10K, 100K, and 1M ohms plus external position. **Collector voltage range:** 0.3 to 60 volts. **Collector current range:** 0.3 μa to 30 ma. Also measures FET's. **Price:** $4995

Model 340

R.F. TRANSISTOR NOISE ANALYZER

Measures noise figure directly of transistors and FET's at radio frequencies. Plug-in heads available for test frequencies between 1 MHz and 60 MHz. **Noise figure range:** 0 to 40 db. **Base resistance range: 50,** 100, 200, 500, 1K, 2K, 5K ohms. **Collector voltage range:** $\pm$ 1 to 30 volts. **Collector current range:** 30 μa to 30 ma. **Price:** $2500

Model 1340 TRANSISTOR TEST HEADS

1340 - 1 MHz - 10.7 MHz
1340 - 2 MHz - 45 MHz - 60 MHz **Price:** $1800

Model 1341 LINEAR I.C. TEST HEAD

Measures noise in integrated circuits at 10.7 MHz. **Price:** $1800

Model 310 TRANSISTOR NOISE ANALYZER

Measures noise current and voltage at 100 Hz, 1 KHz and 10 KHz as well as I_{cbo}, I_{ebo} and beta. **Noise spectral density range:** 0.01 to 3μv, FS. 1 to 300 pa, FS. **Collector Current range:** 0.05 to 30 ma. **Collector voltage range:** 0.1 to 30 V. **Base resistance range:** 0, 500, 1K, 10K, plus external position. **Price:** $2725

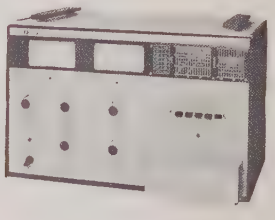
Model 311

Similar to above, except that collector current range is from 2.5 to 1000 μa for noise measurement in low-collector-current devices. Measures Gm instead of beta. Also measures FET's. **Price:** $2725

Model 2283 -2181

INTEGRATED CIRCUIT NOISE ANALYZER

This extremely versatile noise measuring system was designed primarily for measuring noise in linear IC's and Op Amps. **Bias voltages:** plus and minus 12V fixed, plus and minus 0 to 30V independently variable at 100 ma. **Noise spectral density:** 3 to 3000 nanovolts. **Filter frequencies:** 10 and 100 Hz, 1, 10, and 100 KHz measured simultaneously. **Price:** Model 2283 Control Unit $1600
Model 2181 Filter Unit $2500



Model 315B

RESISTOR NOISE TEST SET

Measures noise in resistors in conformance with specifications recommended by N.B.S. and Method 308 of MIL. STD 202B. **Test-Resistor range:** 1 Ω to 25 Meg Ω. Measurement range 0.6 μV to 1000 μV in a decade of frequency. **Outputs:** Sample of noise voltage; analogs of meter readings. External cable available for remote location of test jig. **Price** $2700

Model 512B

TRANSISTOR NOISE TEST SET

Measures Broadband and Low Frequency noise figures directly in dB. Noise Bandwidths 15.7 KHz (—3 dB at 10 Hz and 10 KHz) also L.F. 10 Hz to 50 Hz. **Noise Figure Range:** 0 to 62 dB. **Collector Voltage range:** $\pm$3 to 30 volts. **Collector current range:** 10 μA to 1 ma. **Base Resistance:** 50, 500, 1K, 10K ohms & Ext. **Price:** $1495

Model 327 DIODE NOISE ANALYZER

Measures noise in back-biased semi-conductor diodes at 10 Hz and 1 KHz simultaneously. **Noise spectral density range:** 0.03 μV to 1 mV. **Test Voltage:** 0 to 500 V, continuously variable. **Test Current:** 0 to 100 ma continuously variable. Internally supplied ramp automatically sweeps test current and/or voltage within maximum ratings. A wide variety of outputs for data logging, external monitoring, actuating external equipment, etc. **Price:** $3250

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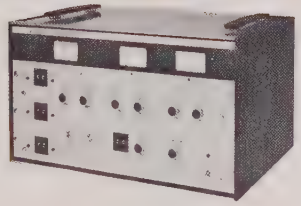
Quan-Tech
Division of KMS INDUSTRIES, INC.

- AUTOMATIC AND SEMI-AUTOMATIC COMPONENT TEST SYSTEMS
- COMPONENT HANDLERS

Model 2310

AUTOMATIC TRANSISTOR NOISE TEST SYSTEMS



Measures 1 KHz, 10 KHz, or broadband (—3 db at 10 Hz and 10 KHz). Noise figure in 200 milliseconds. Front panel reject levels settings and Go-No Go indicators. PASS and REJECT information at rear connector. **Collector Voltage:** ±5 to 30 volts. **Collector Current:** 5 μA to 10 mA. **Noise Figure:** 0 to 20 db. **Base Resistance:** 50 ohms to 99K ohms.

Price: $8000

Model 2307

Similar to Model 2310, but simultaneous tests at 3 frequencies 1 KHz, 10 KHz and Broadband. Not supplied with variable Pass-Reject controls. **Price:** $8000

Model 5012

AUTOMATIC RESISTOR NOISE TEST SYSTEM

Automatic Measurement of Resistance and Current Noise at a speed of 1 test per second for thick or thin film chips. **Resistance Range:** 5 ohm to 1.2 Megohms, digital displays with BCD outputs for recording. **Test power:** 0.1 or 0.25 watts (250V max.) selectable. Test sequence program set by test cable connections. Go-No Go programming, spot scan selection and special test fixtures available.

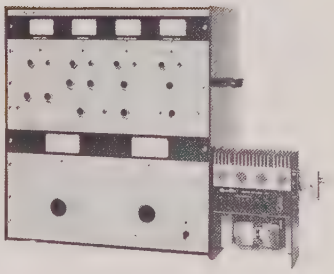
Model 005

SEMI-AUTOMATIC COMPONENT HANDLER-SEGREGATOR

Portable bench mount Component Handler-Segregator. Fluidic control systems with variable timing. Tests and sorts items into 3 or more categories, at speeds up to 3000 devices per hour. Positions for 2 separate test heads. Rapid changeover for different test devices. **Price:** $7500

Model 2214

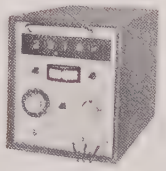
DYNAMIC AMPLIFIER TEST SYSTEM



For dynamically testing linear integrated circuits or any amplifier system. Measures total distortion, output voltage, spot noise and Broadband Noise simultaneously. Test power to 60 watts. Test times from 180 to 330 milliseconds. Go-No-Go Programming. Automatic or manual operation. Easily interfaced with automatic component handlers. Special test jigs and digital recording outputs available. **Price:** $10,200

Model 167

AUTOMATIC RESISTANCE CAPACITANCE AND INDUCTANCE BRIDGE



Fully automatic component bridge with digital readout of value. **Ranges; Resistance:** 1 Ω to 11 MΩ. **Capacitance:** 1 pf to 11 μF. **Inductance:** 100 μH to 1100 H. **Accuracy:** better than 0.1%. Digital outputs for permanent recordings.

Price: $3000

Model 367 PROGRAMMED LIMIT DETECTOR

Interfaces with Model 167. Front panel settings of high and low limit values — Pass or fail front panel lamps and rear panel data. **Price:** $1100

Model 467 IMPURITY DIGITIZER

Interfaces with Model 167. Automatic digital readout of Q or tan d. Accuracy 1%. **Price:** $2150

Model 368 COMPONENT COMPARATOR-CLASSIFIER

Automatic measurements of C, R or L also dissipation factor, Insulation Resistance test and Flash test. Dial in Nominal value, % tolerance selections in 0.1% steps to an accuracy of 0.03% up to 12 classifications at a speed of 1 classification every 40 milliseconds. Reject levels for tan d, excess leakage, flash breakdown, high and low component values.

Model 270

D.C. INSULATION RESISTANCE TESTER

Measures d.c. insulation resistance up to 6.8×10^{12} ohms. Test voltage up to 3 kilovolts, pass or reject programming.

Price: $2000

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Quan-Tech

Division of KMS INDUSTRIES, INC.

- SOLID STATE AMPLIFIERS
- AMPLITUDE DISTRIBUTION ANALYZERS
- RANDOM NOISE GENERATORS

Model 420

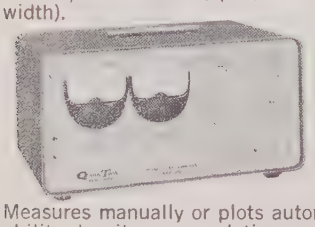
RANDOM NOISE GENERATOR

Stable "white" noise output having true gaussian amplitude distribution. **Frequency range:** DC to 100 KHz; **Output spectral density:** 0.01 to 1000 μV, continuously variable, calibrated; **DC offset:** less than 10 mV at max. output.
Price: $700

Model 421

RANDOM NOISE GENERATOR

Similar to Model 420 but covering higher frequencies. **Frequency Range:** 10 KHz to 12.5 MHz flat $\pm$0.5 db. **Output Spectral Density:** .02 to 300 μV, continuously variable, calibrated, into 75 ohms. (1.34V RMS maximum for full bandwidth). **Price:** $1100



Model 317B

PROBABILITY DENSITY ANALYZER

Measures manually or plots automatically amplitude probability density or cumulative probability functions of random, complex, and repetitive signals. **Frequency Range:** DC or 10 Hz to 1.75 MHz. **Sweep:** —3 sigma to +3 sigma, automatic or manual. Gated clock pulse for low probability density. **Price:** $990

Model 317

AMPLITUDE DISTRIBUTION ANALYZER

Determines amplitude-probability distribution of random signals. **Amplifier response:** 3 db down at approx. 12 Hz and 1 MHz; **Switching rate:** 5 MHz. **Amplitude ranges:** 100%, 10%, 1% F.S.; Normal or "inverted" operation; provision for external sweep of level. **Price:** $495

Model 318

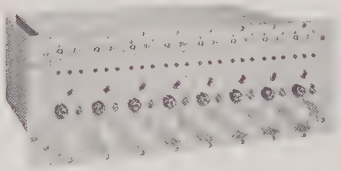
IMPULSE DISTRIBUTION ANALYZER

Determines amplitude and width of random or repetitive pulses. **Frequency Response:** DC to 15 MHz. **Amplitude Sensitivity:** —10 dbm to —60 dbm. **Input Impedance:** 75Ω, 135Ω and 600Ω. **Width Analysis:** 100 ns to ∞. **Price:** $4500

Model 2365

AUTO-RANGING A.C. AMPLIFIER

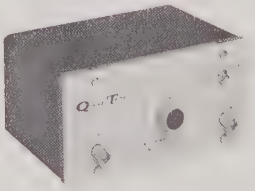
Functions: Autoranging, manual or remote program (BCD). **Voltage gain:** 0 to 78 db in 6 db steps, front panel digital display. **Bandwidth filter:** High pass; 10 Hz and 400 Hz. Low pass, 4 KHz, 20 KHz and 100 KHz selectable with front panel display. **Price:** $1350



Model 2220

INSTRUMENTATION AMPLIFIER

Modular amplifiers mount 8 units in a 7" rack panel. **Voltage gain:** 0 to 80 db in 5 db steps. **Controlled frequency characteristics:** (selected by plug-in cards) voltage gain flat 10 Hz to 100 KHz or 10 Hz to 20 KHz, rising 3 db/octave 10 Hz to 100 KHz or 6 db/octave 10 Hz to 20 KHz. **Price:** $590
*Digital Outputs Available



Model 206 B

SELECTABLE GAIN AC AMPLIFIER

Bandwidth: 1 Hz to 100 KHz (within 0.5 db); —3 db at 500 KHz. **Typical noise spectral density:** 5 x 10^{-9} V and 3 x 10^{-12} A at 1 KHz. **Gain:** 10, 100, & 1000, selectable at front panel; **Power:** 105-125 V AC or optional self-contained battery pack (automatically recharging). **Price:** $240
Batteries: $35

About Quan-Tech

Quan-Tech specializes in the amplification and measurement of extremely low level signals which approach the theoretical limits of sensitivity. This capability enables us to offer a technical service in the development, design and manufacture of custom electronic equipment, instrumentation and systems which challenge the state of the art. We invite inquiries which put us to the test.

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612-920-7080

3512 Rockville Road
Indianapolis, Ind. 46222
317-243-6681

Missouri, Kansas, Nebraska

S. STERLING COMPANY
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St. Louis, Missouri 63141
314-542-3636

KANSAS CITY
9421 Pflumm Rd. Room 132
Lenexa, Kansas 66215
913-888-2995

Texas (except El Paso), Arkansas, Oklahoma

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Dallas, Texas 75234
214-243-2141

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212-689-5212

Montana, Idaho, Wyoming, Utah, Colorado, New Mexico, Texas (El Paso area)

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Golden, Colorado 80401
303-279-7138

3605 S. Bannock St.
Salt Lake City, Utah 84120
801-299-4321

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